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Evaluations on list undercoverage bias and possible solutions: the case of ISTAT CATI survey "Trips, holidays and daily life"

Claudia De Vitiis, Paolo Righi¹

Abstract

The list of fixed line telephone numbers, used as sampling frame for CATI surveys on households, suffers of an increasing undercoverage rate. Some methodological studies conducted on ISTAT CATI household surveys have pointed out the risk of biased estimates for particular phenomena of interest due to this type of frame imperfections. A research group in Istat has been set up and has highlighted a risk of estimation bias due to the undercoverage effect for the Trips, holidays and daily life survey, for which data are collected by means of CATI technique on a sample selected from the phone directories. In the paper two possible approaches to pursue unbiased estimates are described. The first one is based on the enhancement of the estimator aiming at taking into account the frame imperfections. An experiment on real survey data shows a good improvement on the undercoverage bias of the estimates choosing more properly the calibration variables. The second approach defines a different survey strategy, based on a different frame not suffering from undercoverage (or most likely less affected by undercoverage), the set of municipal population registers, together with a new sampling design and a mixed mode data collection.

Keywords: Frame Undercoverage, CATI Surveys, Sample Design and Estimation, Official Statistics

1. Introduction

In recent years the fixed line telephone has lost increasing quotas of population coverage, as shown in several studies about U.S. (Blumberg *et al.* 2008) and the European Countries (Kuusela *et al.*, 2008). In Italy the overall percentage of households covered by a landline telephone has decreased from 84.7 in 2001 to 71.9 in 2008, while the mobile phone only households increased from 10.2 in 2001 to 25.6 in 2008 (ISTAT, 2009b and 2009c). Moreover, the rate of non fixed line households is not uniform across population (Callegaro and Poggio, 2005; Istat, 2009a).

These circumstances produce relevant implications for the household sampling surveys carried out by means of the CATI (Computer Assisted Telephone Interview) technique, which are commonly based on a sample selected from the list of fixed line telephone. Telephone surveys are a cost-effective and timely method for conducting household surveys. Nevertheless,

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a major drawback of this data collection mode is that it covers only households with fixed line telephone, leaving not covered by the sample the sub-population of households without telephone, with exclusive mobile phone or using reserved fixed lines numbers. The estimates produced by these surveys could be affected by a certain degree of bias if referred to the whole population, because of the undercoverage rate of the list and when the population units belonging to the list are different from the units excluded by the list with respect to the target variables (Lessler and Kalsbeek, 1992).

To deal with undercoverage bias, a research group has been established at the Italian National Statistical Institute (Istat). In order to verify and to assess this suspected bias, several analyses have been carried out using the data of the *Multipurpose survey on households: aspects of daily life* (in the following indicated as MPS, Istat 2009c). MPS is based on a sample of households selected from the municipal registers and, for this reason, it can be reasonably considered not affected by severe frame undercoverage and, therefore, producing approximately unbiased estimates. This survey collects some variables which are observed in the main CATI household surveys as well. Moreover, the MPS collects the presence of a fixed line telephone in the sample households; this fact allows to individuate in the overall sample the subsample of the households covered by fixed line telephone, which can be considered similar to the sample contactable through the CATI surveys selected from the telephone list.

The results of the research group highlighted significant differences, reported in the Istat technical report (2009a), among the estimates of some interest variables obtained on the whole MPS sample and the same estimates obtained on the subsample of the phone-owner households, consequently reachable through a survey using the telephone list. In particular, the analysis carried out by the group stressed a suspected bias for a variable that is quite similar to one of the main target variables of the CATI survey *Trips, holidays and daily life* (THS, Istat 2009d).

This paper shows the activities described in the second report of the working group Istat (2009b) and, in particular, the planning of the simulative procedure for analyzing the bias of THS and two solutions to deal with bias caused by frame undercoverage, either proposed by the authors. As far as the solutions are concerned, the first one improves the calibration estimation procedure without modifying the frame of the survey (Särndal and Lundström 2005, ch. 14) and the sample selection scheme, the second one consists in a complete redesign of the sampling design, based on the use of a better population list and a mixed mode data collection technique (Brick and Lepkowski, 2008). For the second case it is relevant to stress the CATI technique still remains the preferable way of conducting interviews for the timeliness and the quality of data and for cost reasons as well.

The paper is articulated in the following sections: section 2 describes the definition of the simulative context and the analysis of the undercoverage bias arising from the experiment; section 3 reports the driving steps for defining a new estimator taking more carefully into account the undercoverage bias. The study is supported by an empirical analysis of the property of the new estimator in terms of bias. The experiment is based on MPS data, in which is observed a variable similar to the fundamental variable of interest of the THS. Section 4 is devoted to the definition of a two stage sampling design for the THS, using a more exhaustive selection list, attempting to preserve the estimates from undercoverage bias. Section 4.1 gives an empirical evaluation of the design effect of the estimates based on MPS data, as the current THS is based on a one stage sampling design and the proposed design can possibly produce a negative impact on the sampling errors. In Section 5 some conclusions and a future research path are given.

2. Bias Assessment in the Survey on Trips and Holidays

Bias estimation is quite a complex issue in the sample surveys. Sampling theory gives some general frameworks for avoiding biased estimates and some methodological tools for bounding the bias when the sampling survey is planned out of these frameworks. In the paper we take into account the randomization-assisted survey sampling approach. The inferential approach guarantees the unbiasedness when each population unit has a sample inclusion probability greater than zero. Generally, this condition does not hold when using a fixed line telephone list due to the undercoverage. Theory shows that the undercoverage produces biased estimates unless the undercoverage is MCAR (Little and Rubin, 2007). Moreover, when the undercoverage is MAR the researcher may remove the bias with suitable estimators. Usually, the undercoverage model is more complex and assuming a MAR mechanism the bias may just be bounded.

In the THS the high rate of undercoverage of the list leads to suspect that the estimates might be biased. Nevertheless, the quantifying of bias is impossible in a direct way because the parameter of interest and the undercoverage mechanism are unknown. In these cases the bias can be assessed only indirectly and in a simulative or experimental context.

The bias of the THS has been evaluated by means of an experiment based on the MPS data. The MPS sample of household is drawn according to a two stage sampling design. Data are collected by means of PAPI (Paper And Pencil Personal Interview) technique. MPS uses currently a calibration estimator benchmarking the number of persons by sex and age classes at regional level.

The choice of using MPS data has been suggested by the following aspects:

- the sample is selected from a theoretically exhaustive demographic lists (the municipal registers). In practice, the demographic lists may suffer from undercoverage (or overcoverage or duplication of the population units), but we assume the phenomenon is much less relevant with respect to the undercoverage of a telephone list. Furthermore, we assume these are the best demographic lists, currently, available. Quality enhancement of the lists should require an expensive “ad hoc” procedure;
- MPS collects many socio-economic variables (sex, age, educational level, professional position, etc.) observed also in the THS;
- MPS collects the “yes/no variable about at least one Overnight Stay lasting Four nights or more (OSF) in a collective accommodation establishment for holiday, during the last twelve months”. This variable is quite similar to the most representative variable of the THS. In the experimental study we suppose that if an evidence of bias on the total estimation of the OSF variable is found, then we can infer that a bias on the estimation of THS variable is also likely;
- MPS collects the “yes/no fixed line phone owner” variable, hereinafter denoted by fixed line phone owner. Therefore, it is possible to distinguish the sub-sample of MPS reachable by a survey using CATI techniques such as in the THS.

Assuming that the municipal registers are affected only marginally by list errors, the sub-sample of fixed line phone owner is representative of the population of the fixed line phone owner households due to the randomization-assisted (or design-based) approach used in the MPS sample strategy. That implies that the estimated frequencies on the fixed line phone owner sub-sample are unbiased estimates of the fixed line phone owner population.

The bias assessment of the OSF estimates is carried out in a simulative context comparing the MPS estimates with the estimates based on the MPS phone owner sub-sample and the THS estimator.² Hence, we do not use the current estimates of the MPS but we consider a simulated estimation process performed currently in THS.

In this way, assuming that the MPS produces in general unbiased estimates (hereinafter denoted by reference estimates), the comparison may suggest that the possible differences depend on coverage and estimator only, because we use data which are equal regarding all the other conditions. Moreover, by the randomization-assisted approach the THS estimator produce unbiased estimates when there are not frame errors. Therefore, in the proposed comparison significant differences between couples of estimates should depend on the undercoverage problem of phone owner sub-population. We underline that the THS presents some substantial divergences with respect to MPS not only regarding the frame and estimator. The survey uses different sample design, sample size, survey techniques and a slightly dissimilar definition of the interest variable. If we had compared directly the MPS and THS estimates, the possible significant disagreements could have derived from a lot of causes such as: unlike definition of the interest variable; different survey techniques (respectively PAPI and CATI) having unequal effect on measurement errors and on rate of non response. Basing the analysis on such data it would be difficult to detect the bias due to undercoverage.

A final assumption necessary to obtain the simulative comparison is that the response probability in the MPS must not depend on fixed line phone owner variables. We believe that the assumption is good enough in the sense that is negligible the dependence of the household non response from the fixed phone owner variables.

Table 1 shows the results of the simulative comparison.

Table 1 - Estimates of relative (%) frequency distributions of the number of person per at least one Overnight Stay lasting Four nights or more (OSF). Estimates obtained by means of the MPS estimator on the overall MPS sample (type a estimate) and by means of the current THS estimator on the MPS sub-sample of the phone owner households (type b estimate) (year 2008 data)

OSF	<i>Type a</i> estimates and confidence interval		<i>Type b</i> estimates and confidence interval	
No	48.7	(47.8-49.5)	44.4	(43.4-45.5)
Yes	50.3	(49.5-51.2)	54.6	(53.5-55.7)
No-response	1.0	(0.9-1.2)	1.0	(0.8-1.2)

Source: Elaborations on Istat data

The main results are the not overlapping of the confidence intervals computed by means of the two estimation procedures. We explain them as a sign of biased estimates due to undercoverage. These findings have led to define two approaches (see section 3 and 4) for harmonizing the compared estimates.

² The THS current estimator is calibrated with respect to the following known totals: population by sex and region; population by municipal type; population by age groups; households by size.

3. Calibration approach

The first approach to deal with the bias deriving from the undercoverage of the telephone list leaves substantially unchanged the survey design (sampling design and the selection frame) and aims at improving the estimation procedure. This is done by introducing in the estimator, which is generally a calibration estimator, additional or different auxiliary variables, more correlated with the survey variables or with the undercoverage phenomenon. The approach assumes the existence of a relationship among the target variables and some auxiliary variables observed in the sample units and for which either the totals are known at population level or unbiased estimates with small sampling variance are available. We introduce these variables in the calibration procedure, modifying the current calibration estimator. Adding these benchmarking variables, the final estimates of the totals of the new auxiliary variables will be equal to the known (or estimated) totals.

The use of the calibration approach is one of the possible ways to deal with undercoverage at the estimation phase (Särndal and Lundström 2005, ch. 14). The approach is based on the following assumption: if the new estimator corrects the biased sampling distribution of the explaining (auxiliary) variables of the target variable, then the estimator corrects, at least partially, the bias of the estimates of the target variable as well. Another standard reweighting approach is the propensity score weighting method (Rosebaum and Rubin, 1983; Lee and Valliant, 2008). The approach usually relies on logistic regression modelling and is sometimes referred as logistic regression weighting. Propensity score method requires the knowledge of the auxiliary variables for the overall population and this aspect may restrict its use. On the contrary, calibration approach needs to know the auxiliary variables at sample level and the totals at population level. Cobben and Bethlehem (2005) made an interesting and quite exhaustive application of the two approaches on real survey data.

Starting from the findings of table 1, the calibration approach has been tested on the MPS data referred to 2008. Before defining a new estimator, the following steps have been performed:

- a logistic regression model fitted on MPS data has identified some significant socio-economic variables in explaining the probability to have yes for the OSF variable (Istat 2009a);
- the estimates of the sampling distribution of the significant socio-economic variables obtained on the sub-sample of fixed line telephone owner households were computed using the current THS estimator;
- the comparison among the estimates computed with the current MPS estimator based on the overall household sample and the estimates with the THS estimator on the fixed line telephone owner households has been performed by means of a Chi-square index and taking into account the confidence intervals overlapping;
- finally, some socio-economic variables presenting different estimated distributions when obtained with MPS and THS estimators are introduced in the system of constraints of the THS calibration estimator if they are not already used in the current estimator.

The analysis of the logistic model (accomplished by the research group, Istat 2009a), outlines that there are several variables which are explicative for the yes probability of OSF variable. Therefore, a selection process of the variables to be taken into account has been

necessary. Otherwise, with so many benchmarking variables, the calibration procedure would become unfeasible. Firstly the variables not collected in the THS such as income level, possession of durable goods, type of dwelling have been discarded. Then, the variables, marital status, household size, nationality, that do not show significant differences in the estimated distributions by the two compared sampling strategies have been left out. Moreover, the age of the head of the family has not been considered: even though it is a significant variable, the logistic model evidences have a complex interpretation with respect to the connection with the probability of yes for the OSF variable. Hence, the preliminary steps have led to include the variables Educational Level (EL) and Professional Position (PP) in the set of the additional calibration variables.

Table 2 and 3 show the estimated distributions of the selected variables obtained by means of the overall MPS sample using the current MPS estimator and the MPS sub-sample of the fixed phone owner using THS estimator. The estimated distributions obtained through the two estimators appear unlike.

Table 2 - Estimates of relative (%) frequency distributions of Educational Level. Estimates obtained by means of the MPS estimator on the overall MPS sample (type a estimate) and by means of the current THS estimator on the MPS sub-sample of the phone owner households (type b estimate) (year 2008 data)

EDUCATIONAL LEVEL	Type a estimates and confidence interval		Type b estimates and confidence interval	
Doctorate, degree	8.9	(8.5-9.2)	10.8	(10.1-11.5)
Upper secondary school certificate	26.0	(25.4-26.6)	30.1	(29.0-31.2)
Lower secondary school certificate	35.3	(34.7-35.9)	32.7	(31.6-33.8)
Primary school certificate, no education	29.9	(29.4-30.4)	26.4	(25.4-27.4)

Source: Elaborations on Istat data

Table 3 - Estimates of relative (%) frequency distributions of Professional Position. Estimates obtained by means of the MPS estimator on the overall MPS sample (type a estimate) and by means of the current THS estimator on the MPS sub-sample of the phone owner households (type b estimate) (year 2008 data)

PROFESSIONAL POSITION	Type a estimate and confidence interval		Type b estimate and confidence interval	
Manager	1.0	(0.9-1.2)	0.7	(0.5-0.9)
Executive / Clerk	14.2	(13.8-14.6)	23.5	(22.5-24.5)
Workman / workwoman	12.6	(12.2-13.0)	15.4	(14.6-16.2)
Entrepreneur, Professional	3.3	(3.1-3.5)	2.9	(2.5-3.3)
Coordinated free-lance worker	1.3	(1.2-1.4)	-	-
Self-employed, Collaborator in the family Business	5.7	(5.4-6.0)	5.1	(4.6-5.6)
Not employed	61.8	(61.3-62.2)	52.3	(50.9-53.7)

Source: Elaborations on Istat data

In many cases, as the confidence intervals do not overlap, we assume that estimated frequencies are significantly different. Furthermore, we assume the estimates based on the overall sample of MPS as unbiased and by the consequence the estimates based on the MPS sub-sample and THS estimator as biased. It is worthwhile to note that these are the only distributive evidences for the variables EL and PP and no indication at population level are available.

The EL and PP variables have been introduced in the set of the calibration variables of the THS estimator.

Table 4 shows the estimated distribution of the OSF variable having introduced the EL variable in the calibration system, based on the sub-sample of the phone owner households (*type c* estimated distribution). The distribution is more similar to the reference estimates with respect to the estimated distribution based on the sub-sample of the phone owner households and the current THS estimator (*type b* estimated distribution of table 1). Table 4 also shows the results of the calibration process on the sub-sample of phone owner households when EL and PP are in the set of calibration variables (*type d* estimated distribution). We may observe a further reduction of the bias with confidence intervals almost overlapping the confidence intervals of the reference estimates. Therefore, table 4 shows that significant improvements of undercoverage bias reduction by using a suitable calibration procedure are possible.

Table 4 - Estimates of relative (%) frequency distributions of the number of person per “at least one Overnight Stay lasting Four nights or more” (OSF), obtained on the MPS sub-sample of the phone owner calibrating on the auxiliary variables currently used in the THS estimator plus EL variable (*type c* estimate) and plus EL and PP variables (*type d* estimate) (year 2008 data)

OSF	<i>Type c</i> estimate and confidence interval		<i>Type d</i> estimate and confidence interval	
No	46.0	(45.0-47.0)	46.4	(45.4-47.4)
Yes	53.0	(52.0-54.0)	52.6	(51.6-53.6)
Non-response	1.0	(0.8-1.2)	1.0	(0.8-1.2)

Source: Elaborations on Istat data

Finally, we have to point out that table 4 gives downward biased estimation of the sampling errors of the *type c* and *d* estimators, because they are computed assuming the totals of the new benchmarking variables as they were known while they are estimated. Nevertheless, we underline that unbiased variance estimations in table 4 would enlarge the confidence intervals generating a greater overlapping among the confidence intervals obtained with the estimates based on the MPS overall sample and the MPS estimator.

The proposed approach refers to the sample weighting adjustment methods (Kalton and Kasprzyk, 1986). The aim of these methods is to reduce the undercoverage bias. A drawback is the increasing of the variances of the survey estimates. A second issue to deal with regards the possibility to utilize such an estimator in the current THS, which is based on a relatively small sample, on which the convergence of the calibration procedure is not guaranteed. The trade-off between bias and variance and convergence are not faced in the paper, but it will have to be taken into account in an application of the approach.

4. Redesigning a CATI survey: selection from municipal registers by a two stage scheme and mixed data collection technique

In the survey context under examination, an alternative approach to deal with the declining coverage of the fixed telephone list is the use of a different selection frame, guaranteeing a very high level of coverage of the target population. At present, the only list covering theoretically the whole Italian population is the set of municipal registers available at

each Italian municipality. Even though this list may suffer from some coverage error (both over and under coverage), we can assume that these failures are much less relevant than those encountered in the telephone list. The municipal lists are currently used for the household surveys carried out through face to face interview. If THS will be based on these lists a new sampling strategy is required. In fact, as a unique list of households is not available and each municipal register is obtainable only in each municipality, the sampling selection scheme has to be similar to those ones commonly used at Istat for household survey with selection from municipal register: a two stage sample scheme, in which the municipalities are the PSUs (primary sampling units) and the households the SSUs (secondary sampling units).

After the selection of the sample households the proposed approach requires a delicate phase of linking the sample units to the list of fixed telephone numbers. The aim is to contact the sample units by means of the telephone as much as possible. In this way multi frame approach, together with a multi-mode collection technique is proposed.

The approach resorting to such a different frame will imply the definition of a different sampling scheme and the use of different interviewing technique to be added to the usual CATI method for those units not reachable through a fixed telephone. Nevertheless, the CATI technique remains the main interviewing mode for its cost effectiveness.

This solution is suggested in Nathan (2001), while a relevant review of multi frame and multi-mode issues is reported in Lepkowski et al. (2008).

The linkage phase will produce a positive result only for a part of the sample households, both for errors of linkage and for real absence of a fixed line. At present, evidences from the Istat Labour Force Survey (Istat 2009b) show that in general the linkage rate between a list of households (selected for the survey from the municipal registers) and the fixed line telephone directories is around 40% at national level, being slightly higher in the North and Center of Italy, while it is lower in the region of the South.

While for the sub-sample of units linked to a fixed line number the CATI mode can be applied, for the remaining ones the interview has to be carried out through a different technique: by CAPI (Computer assisted Personal Interview), which it is the most expensive one, or, more conveniently, the CAWI (Computer Assisted Web Interview). The CAPI technique will be used also for those households not reachable through the linked telephone numbers, in order to avoid the substitution of such units, which is a not recommended practice if the aim is to reduce the bias of the estimates.

In some case an attempt can be done in order to get from the non-linked households the number of a fixed line, asking it directly to them by means of a letter sent to their address. In this way a part of the “uncovered” households could be retrieved and they could be interviewed through the CATI mode. A first experiment of this approach will be performed in the Istat Adult Education Survey, which will be conducted in 2011 on a sample of 6,000 households, following this proposed mixed mode collection technique and the selection of the sample from the municipal registers.

In this context, another relevant issue under discussion is the possibility to conduct CATI interviews through mobile telephone numbers. Although this interviewing mode has been already experimented giving good performances (Bethlehem, 2009), at present a complete list of mobile telephone numbers to be linked to a sample of individuals or households is not available (mostly for legal reasons). Therefore, this possibility cannot be considered in our context and mobile interviewing can be considered only for taking appointments after a first contact through a fixed line.

The multi-mode data collection, mainly CATI mode, addresses the need for timeliness and cost reduction at the same time; using the CAPI technique for the overall sample indeed, abandoning the telephone interview at all, would be much more expensive. On the other hand, the use of several survey techniques yields different effects on the survey estimates. For instance, because the questionnaire must be modified according to the data collection mode, or because the interviewers have a different role in the mode collection or may not be employed. The mode effect together with advantage and drawbacks of multi-mode survey are discussed in Lepkowski et al. (2008). The focus of the paper is on the evaluations of a survey redesign based on a two stage sampling design using CATI and/or CAWI when possible, with reference mainly to the sampling aspect. This is a first step for planning a multi-mode surveys but not the only one. The subsequent evaluations (questionnaire, interviewer effect, ect.) must be taken into account with field experiences. The results of the Adult Education Survey will provide useful indications.

As far as the sampling aspects are concerned, a relevant element has to be taken into account: a two stage sampling scheme produces in general an inefficiency effect due to the level of similarity of elementary units within the selected clusters, with respect to the survey variables: the more similar to each other the units belonging to the clusters, the higher the increase of inefficiency of the estimates. This effect, known as *design effect* (Kish, 1965), can be limited, in general, by selecting a large number of PSUs and therefore a small number of final units in each PSU. In the case under study, the only reason to limit the number of sample municipalities is due to the necessity to get access to each municipal register. The use of CATI technique, eliminating the need for the interviewers to go personally to the houses of the sample households, allows, on one hand, to widen the sample of PSUs obtaining an improvement of the efficiency of the estimate, and enables, on the other hand, to reduce the cost of the survey, being the CATI much cheaper than a face to face interview. In order to obtain an adjustment of the cost of the redesigned survey, it is possible to operate on three alternatives: selecting a very large number of municipalities keeping the number of sample final units similar to the current one, increasing the number of final units in the sample keeping the number of municipalities small, or balancing both numbers at the same time.

In any case, to fix the parameters of the two stage selection scheme (the size of first and second stage sample and the number of sample households for each sample municipality), it is necessary to carry out evaluations on the efficiency of the estimates to be obtained, which varies from survey to survey depending on the intracluster correlation coefficient of the specific variables.

It is useful to point out that this sampling approach presents very good advantages together with some drawbacks. The advantages are: it mostly resolves the problem of undercoverage bias assuming the municipal registers are less affected by undercoverage; it allows to limit the increase of the costs of the survey as a high quota of CATI interviews is preserved. On the other hand, the disadvantages are: the problems of linkage between sample households selected from municipal registers and the telephone list; the difficult to know in advance the quota of linked sample units while the knowledge of this subdivision of the sample is fundamental for fixing the parameters to plan the two stage sample design (number of PSUs, SSUs per PSU and total sample size); the need to handle differently the nonresponse and measurement errors according to each data collection techniques.

Furthermore, we remark that the proposed approach is based on the use of well consolidated sampling, estimation and data collection techniques in the Official Statistics. These properties do not necessarily improve estimation quality, but they are appreciated from the operative point of view, especially in large scale surveys, where the data production processes are complex and the introduction of not frequently used tools can create some troubles and can worsen the data quality.

4.1. First evaluations on a redesign of the Survey on Trips and Holidays

The THS has resulted to be exposed to the risk of bias deriving from the undercoverage of the selection list, as shown in (Istat 2009a) and in section 2. To follow the redesign approach, the use of an exhaustive population archive is required. As stated in previous section, the most natural population archive is the municipal registers, giving rise to a two stage sampling scheme and a multi-mode data collection, CATI for the part of the sample to which it is possible to link a fixed phone number and CAPI or CAWI for the other part. It is important to underline that for this particular survey the use of the a computer assisted interview is crucial, essentially for timeliness reasons, being the survey obliged to send quarterly data to EUROSTAT; in this context the CATI and the CAWI technique would be better because they would allow also to limit the survey costs.

Through the adoption of such a sample strategy it should be possible to reduce consistently the part of the total error of the estimates due to the undercoverage of the list, and maintaining at the same time the sampling error at the same level as it is currently, by increasing if necessary the overall sample size.

In this context some analysis have been carried out to obtain some evaluation about the required sample size to realize a two stage sample scheme, with the aim not to worsen the precision of the estimates of the survey. The analysis has been made in term of *design effect* of the estimate of the parameter related to the OFS variable, described in the previous section 2. The design effect is a measure of the impact on the sampling variance of an estimate deriving from the use of a complex sample design, in comparison with a simple random sample with the same sample size (Kish, 1965). For a two stage design this quantity is generally greater than unity, owing to the *intracluster correlation coefficient* ρ , which expresses the similarity among units belonging to the same cluster with respect to a given survey variable.

The expected necessity to increase the number of sample units derives from the fact that at present the survey is based on a single stage stratified sample selection, directly from the fixed phone directory, being such a design a very efficient one. For example, in general, a design effect equal to 2 would require an increase of the sample size equal to $\sqrt{2}$, passing from a simple random sample to a two stage design.

From the empirical analysis on the MPS data, which derive from a two stage sample design municipality-household, the first finding is that the ρ shows very high values within the "household" clusters, while the effect of grouping the sample households in sample municipalities is weak. In Table 5 are shown the design effect of the OSF variable in the different considered samples of MPS and THS. Surprisingly, for the analogous OSF variable collected in the THS (based on a single stage design) it can be observed a design effect higher than in MPS: 1.83 for the latter and 1.90 for the THS, both at national level for the last available survey year 2008. Going into details of MPS data separately for the self representative (SR) and

non-self representative (NSR) part of the sampled municipalities, the data show that the design effect is around 1.6 for the SR part and around 2 for the NSR part. All this numerical results have been obtained by means of the generalized software GENESEES, currently used at Istat for the calculus of calibrated sample weights and estimates of sampling errors.

Table 5 - Estimates of design effect for the variable “at least one Overnight Stay lasting Four nights or more” (OSF), obtained on MPS (total sample and telephone owner sample) and THS sample data (year 2008 data)

SURVEY DATA	Design effect	Intracluster correlation coefficient	Sample size
<i>Multipurpose Everyday Life Survey</i>			
Total sample- Type a estimator	1,83	0,435	48.861
Self Representative part	1,60	1,133	16.620
Non Self Representative part	1,96	0,058	32.241
Telephone owner subsample - Type b estimator	1,93	0,520	30.851
Self Representative part	1,83	1,621	10.601
Non Self Representative part	1,99	0,097	20.250
<i>Holidays and Trips (all SR)- four quarters</i>	1,89	1,650	35.870

Source: Elaborations on Istat data

It is useful to underline the meaning of the comparison between the design effect evaluated on the SR part of the MPS sample and the THS sample. In fact the two sample scheme are similar: THS sample is selected from the fixed telephone list by means of a stratified sample scheme and the SR part of the MPS sample is the part of the sample selected through a single stage design, in which the municipalities constitute one stratum each and are selected in the sample with certainty. The result of the evaluation of design effect states that, with a similar selection scheme, MPS design effect is much lower than the THS one. This result allows to suppose that the impact of undercoverage of the selection list produces a bias (an overestimation) of the design effect. In other words, it seems that in the part of the population covered by fixed telephone the intracluster correlation coefficient is higher than in the whole population, observed through the MPS. This evidence is confirmed by the analysis of MPS data limited to the sub-sample covered by fixed phone: the design effect estimated on this subset of households is higher than the design effect estimated on the whole sample. This result emerges both in the SR and in the NSR part of the sample. Although this analysis is valid with respect to the considered variable OSF, the result is very appealing and would deserve a deeper investigation.

In order to confirm the last findings, the quantities about the design effect have been estimated (Table 6) also with reference to a particular subpopulation, for which the sub-samples of the two surveys are comparable in a better way: the set of metropolitan cities,³ constituting a domain of estimate for both surveys: for this domain a single stage sample selection scheme is performed in both samples. What emerges from this table is that even for the subpopulation of households living in metropolitan towns, the cluster association is higher for telephone owners and, moreover, the THS seems to over-estimates it.

³ The metropolitan cities are: Torino, Milano, Venezia, Genova, Bologna, Firenze, Roma, Napoli, Bari, Palermo, Catania, Cagliari.

Table 6 - Estimates of design effect for the variable “at least one Overnight Stay lasting Four nights or more” (OSF), obtained on MPS and THS sample data referred to the municipalities center of metropolitan areas (year 2008 data)

SURVEY DATA	Design effect	Intracluster correlation coefficient	Sample size
<i>Multipurpose Everyday Life Survey</i>			
Total sample- Type a estimator	1,50	1,015	4.829
Telephone owner sub-sample -Type b estimator	1,65	1,345	2.864
<i>Holidays and Trips</i> (all SR)- four quarters	1,93	2,05	3.919

Source: Elaborations on Istat data

The consequence of these first results about the design effect on the definition of the sample size for a two stage sample design is relevant. In fact, it implies that to reduce the bias produced by the use of the telephone list affected by undercoverage, it is not required an increase in sample size to keep unchanged the sampling error of the estimates. The reason of this fact is that the current THS estimates are already affected by a high design effect due to the strong similarity of the individuals belonging to same household and it is reasonable to expect that, with a two stage design with selection from municipal registers, this design effect will not rise. Therefore, by utilizing a population frame not affected by undercoverage, it would be possible to obtain a remarkable reduction of the total error of the estimates, deriving from the reduction of the bias, together with the maintaining of the level of the current sampling error.

It would be necessary, however, a further experimental phase, through a pilot survey, in order to get estimates of all the unknown parameters about variability and design effect for the other variables of the THS (number of trips, number of nights spent in the trips) not considered in the reported analysis because they are not collected in the MPS, which is at the moment the only source of reference unbiased information.

Finally, a pilot survey should be also fundamental for obtaining evidences about many others issues for the underpinning the proposed redesign. Such issues involve: the quantification of the cost according to the rate of CATI, CAPI and CAWI interviews; the data quality depending on non sampling errors generated by different questionnaires and the interviewer effect acting in the different collection modes.

5. Conclusions

International literature shows extensively that in recent years an increasing proportion of households no longer use the fixed line telephone. This trend potentially saps the reliability of the estimates produced by CATI surveys due to the undercoverage of the fixed line telephone list. In the Italian National Statistical Institute (Istat) to deal with this problem a research group has been established. The first goal of the group has been an assessment of the bias of the estimates produced by some important CATI surveys conducted by Istat. The Trips, holidays and daily life Surveys (THS) has resulted to be exposed to the risk of bias deriving from the undercoverage of the selection list. In the paper two possible approaches to achieve unbiased estimates are proposed. The first approach, maintaining unchanged the sampling design, is based on the enhancement of the estimator to take into account some auxiliary variables, related to the coverage

phenomenon. The second approach defines a new sampling design assuming to use a list not suffering from undercoverage and, consequently, a different sampling scheme. We propose to use municipal registers, because although these registers are known having error list problems as well, we believe the undercoverage phenomenon is less intensive with respect to a fixed line telephone list. If the undercoverage of the municipal registers is not negligible is another issue that should be handled in case of practical redesign.

The evaluations of the bias of the THS estimates and the study of the performances for bounding the bias of the two proposed approaches have been made in a simulative and experimental context. No other ways can be run because the interest parameters and undercoverage mechanism are unknown. The experiment has been based on the data of the Multipurpose survey on households: aspects of daily life. These data allow to give some indication about the estimation bias of the most important THS parameter of interest for several reasons: the MPS observes a sample selected from a list with less undercoverage problems (municipal registers); it collects two useful variables, the presence of the fixed line telephone and the yes/no variable about at least Four Overnight Stays, which is quite similar to the most relevant interest variables of the THS. On the MPS data we have compared the estimates obtained by means of the THS estimator computed on the sub-sample of telephone owner households and the estimate obtained on the overall MPS sample with the estimator currently used in this survey. Considering the last ones as unbiased estimates, the significant differences between the two types of estimates are supposed to be caused mainly by the undercoverage of the telephone frame. The two proposed approaches have been applied and the results have been encouraging on both sides. The enhanced estimator produces a negligible difference with respect to the assumed unbiased estimates of the MPS. The analysis of the proposed redesign highlights that a multi-mode survey, privileging the CATI techniques as much as possible, is a practicable road as the redesign does not required an enlargement of the sample size. Finally, it is worthwhile to note that the two approaches are in some senses original. The use of calibration to set about the undercoverage is well known in literature, but the process to define the explicative variables is unusual. The redesign through multi-mode approach represents a new frontier of the sampling practice and it has never been used in Istat, although is potentially feasible. Further analysis must be arranged on the real data of the THS, and the results will give better indications about the proposed solutions to the undercoverage problem.

Among future perspectives, we can mention that Istat at present, following also the suggestions highlighted by the research group, whose results are reported in this paper, decided to include the THS questionnaire as a module in another Istat household sampling survey, the Consumer Expenditure Survey. This survey is based on the municipal registers and a two stage sample design. In the experimental version this survey makes use of the CAPI technique for all the households in the sample. This choice agrees in some sense to second proposal. The aim of a new Istat research group is to study how to implement the new THS according to the renovated sampling design.

Finally, the evidences emerged from the research group have induced Istat to use the CATI-CAPI technique for the Adult Education Survey, and to redesign the Citizen Victimization Survey from CATI to CATI-CAPI data collection mode, according to the sampling strategy described in section 4.

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Vacancies and Hirings: Preliminary Evidence from a Survey on Italian Employers¹

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Abstract

In this paper we seek to enrich our understanding of the connection between job vacancies and hirings, using a recent experimental survey carried out on a small set of Italian employers. We study some basic facts on friction in job matching that are still unknown, in particular the fractions of hirings which occur without benefit of a prior job vacancy and of vacancies cancelled without being followed by a hiring. We develop an enlarged set of measures of friction including also the proportion of non-instantaneous hirings and the job vacancy duration. The results obtained begin uncovering the above facts and can be regarded as an initial step for other surveys, and then for further developments of job search and matching models. We also deal with some of the main issues arising in the measurement of the job vacancy variable, such as the distinction between point-in-time stocks and flows of vacancies, job openings and unfilled jobs and the possible recruiting practices difficult to be captured by the current job vacancy surveys, providing preliminary evidence also about these facts.

Keywords: job vacancies, hirings without vacancies, non-instantaneous hirings, vacancies without hirings, job-filling rate, vacancy duration, vacancy flows, job openings, unfilled jobs, recruiting practices.

1. Introduction

Information on job vacancies has been increasingly used in economics to measure the effects of friction in job matching on unemployment.³ The key concept in this literature is the hiring function, or the matching function, which has been interpreted and estimated as a (Cobb-Douglas) production function with stocks of vacancies and unemployment as input and the number of hirings per period as output (first by Pissarides, 1986, Blanchard and Diamond, 1989 and Layard et al., 1991, and then by many others, as the comprehensive survey by Petrongolo and Pissarides, 2001 shows).

¹ This paper builds on the work done in the context of my PHD thesis. I wish to express my gratitude to Leonello Tronti and Giuseppe Carbonaro for the supervision of the thesis. I am grateful to Gian Paolo Oneto for the chance I had to carry out this study. I also wish to sincerely thank Ciro Baldi and Marina Sorrentino for the very useful discussions and their invaluable suggestions. I also thank Roberto Gismondi for his methodological support.

In particular, I owe to Marina Sorrentino and Leonello Tronti the original idea of an experimental survey covering the missing information on job vacancies. And I am grateful to them to have suggested this possibility to me and given always extremely valuable and kind advice throughout the design of the survey and the analysis of the results.

The views expressed in this paper are solely those of the author and do not necessarily reflect Istat official positions.

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³ See, in particular, Abraham (1983, 1987), Pissarides (1985, 1986, 2000), Blanchard and Diamond (1989), Jackman et al. (1989) and Layard et al. (1991).

Furthermore, the job vacancy rate has also traditionally been used as a possible leading indicator of cyclical employment dynamics.⁴

Due to the many possible uses of job vacancies, recently the production of statistics regarding this variable has markedly increased. In particular, in 2000, the US Bureau of Labor Statistics launched the new monthly Job Openings and Labour Turnover Survey (JOLTS, see Clark and Hyson, 2001 and Faberman, 2005). In Europe, the job vacancy rate⁵ has been included in the list of the *Principal European Economic Indicators* on the job market. Moreover a regulation regarding harmonized quarterly statistics has been produced, after a transition period when a number of member states started to produce broadly harmonized statistics on the basis of a gentlemen's agreement with Eurostat.⁶ Today almost all of the member states produce quarterly job vacancy statistics. In Italy Istat has been running a quarterly business survey on job vacancies and hours worked since the third quarter of 2003 (see Istat, 2009a, 2009b).

Despite these recent developments in the production of job vacancy statistics, some basic facts concerning friction in job matching are still unknown or only partially known.

In particular, no official current survey collects information on the proportion of hirings which occur without benefit of a prior vacancy and, then, which are outside the standard matching framework. Very little information exists also on cancelled vacancies, which are withdrawn from the market without being filled, in particular on firms' reasons for cancelling job vacancies.

Furthermore, information on job vacancy duration and unfilled jobs as a measure of the unmet labour demand is only rarely collected.

In particular, a complementary sample survey on the duration of job vacancies would give not only valuable information about the duration of job vacancies – as distinct from the average duration of recruitment – but also a possibility to estimate the proportion of instantaneous hirings which occur without a prior vacancy.

Gathering information on the job vacancy duration, the proportion of non-instantaneous hirings and of cancelled job vacancies would enlarge the set of possible measures of friction in job matching in terms of deviations from instantaneous hirings, with respect to the job vacancy rate and the average duration of recruitment. Additional information on the number of unfilled jobs – as distinct from job openings or recruitment processes – would measure the direct effect of recruitment problems on employment.

Moreover, information currently available mainly regards the point-in-time stocks of job vacancies, while both inflows of new vacancies opened and outflows of vacancies filled or cancelled during a reference period are almost never collected. But, a point-in-time vacancy stock within a reference period does not necessarily represent all the vacancies opened during that period, due to a possible unmeasured flow of new vacancies posted and filled shortly before or after that point-in-time.

We study these facts by using the data of an experimental survey on job vacancy flows and duration, purposely carried out in order to start collecting the information on vacancies

⁴ See, for example, Haggard-Guénette (1989), Zagorsky (1998), Amoah (2000), European Central Bank (2002), Australian Bureau of Statistics (2003), Valletta (2005), Ruth et al. (2006) and Mandrone et al. (2010).

⁵ The job vacancy rate is defined as the percentage ratio between vacancies and the sum between vacancies and occupied posts.

⁶ Some member states, in particular the United Kingdom and the Netherlands, were already conducting surveys aimed at producing these indicators.

and their connection to hirings. The experimental survey is carried out on a small non-random sample of Italian firms, aimed at understanding if firms are able to provide data on the above mentioned facts and, if so, at preliminarily measuring them. The sample includes 76 firms selected using ad hoc defined criteria. The very limited coverage of the sample and the restricted number of respondent firms (22) require a special caution in interpreting the presented results.

We first document some of the main issues which arise in the measurement of the job vacancy variable on which, so far, very little evidence exists. Besides the distinction between the concepts of job openings and unfilled jobs and point-in-time stocks and flows of job vacancies, two other issues have been investigated. The first concerns the possible recruiting practices and, then, job vacancies which are more difficult to be captured by the current job vacancy surveys. In particular, the current job vacancy definitions state that active recruiting steps have to be taken by the employers. But, employers could find it difficult to identify the active recruitment steps among their usual recruitment activities. For example, firms could not consider recalls of former employees to be an active step, unless instructed to do so. At the aggregate level, this could have a negative impact on the number of firms with no reported vacancies. The second regards the possible ways in which the employers record job vacancy information and the level of detail of the registered information. In particular, if the employers hold a kind of job vacancies record-keeping in which each job vacancy opened and closed in a period is recorded.

The other set of basic facts analysed pertains to the connection between vacancies and hirings. Attempts have been made to highlight the extent to which hirings do not begin with vacancies and vacancies do not end in hirings and the time needed to fill job vacancies successfully. Then, the enlarged set of measures of friction has been studied. Using the information collected by the experimental survey, in particular the opening and closing date of each job vacancy reported by the respondent firms, we also take into consideration other interesting quantities concerning the job vacancy daily process: the daily job vacancy stocks, the daily job-filling rate and the daily flow of new vacancies.

Despite a key role in theoretical models, few empirical studies consider vacancies and their connection to hirings at the firm level. Our work is related to recent studies analysing the fraction of hirings without vacancies from a theoretical point of view (Farm, 2005, 2010) and estimating them (Davis et al., 2009). These studies can be interpreted “*as efforts to partly unpack the “black box” nature of the matching function*” (Davis et al., 2009, p.4).

The paper proceeds as follows. The next section offers a recognition of the current job vacancy surveys carried out by the EU member states, the United States, Australia and Canada and a short comparison has been made of their main characteristics. Section 3 discusses the current status of the information available on job vacancies by highlighting the information still missing. Section 4 introduces the experimental survey on job vacancy flows and duration, describing its objectives and characteristics. In the two central sections, our attention has been focused on the results obtained by using the data from this survey. First, in section 5, we show some preliminary, but interesting evidence concerning the measurement of the job vacancy variable. Then, in section 6, we deal with those facts on friction in job matching which are still unknown by showing the initial evidence on the fraction of instantaneous and non-instantaneous hirings and of cancelled vacancies and on the job vacancy daily process. Section 7 concludes the paper with a summary of our main contributions and some remarks about various avenues for future gatherings of job vacancy variables.

2. Current Sources of Information on Job Vacancies in Europe, the USA, Australia and Canada

In the last ten years there has been strong pressure from and extensive work within the European Union to produce and disseminate quarterly statistics concerning job vacancies, both for the aggregate countries and for the single member states. The inclusion of the job vacancy rate in the list of the *Principal European Economic Indicators* on the job market and the fact that the production of quarterly job vacancy statistics by EU member states is now subject to a regulation⁷ are, respectively, a signal and an outcome of these efforts. Currently, almost all of the EU countries produce quarterly job vacancy statistics. Some countries have a very long tradition and solid experience in the production of quarterly, or monthly, vacancy statistics. For example, the Netherlands has been conducting such statistics since 1988. Others have only recently started coming out with findings. In Italy the quarterly business survey on job vacancies and hours worked has been carried out by Istat since the third quarter of 2003.

The majority of the member states have carried out regular firm-based surveys to produce job vacancy statistics. Administrative collection has been used only by Belgium, France, Luxembourg, the Czech Republic and Slovenia.

Surveys of help-wanted advertisements are highly uncommon in the EU,⁸ while they seem to be a popular source of vacancy data in the non-EU countries considered in this paper. The US Conference Board has monthly published, since 1950, the Help-Wanted Advertising Index (HWI). Statistics Canada came out between 1980 and 2003 as an index similar to the US one. Five such indexes are currently available in Australia.⁹

The three above mentioned non-EU countries have also had previous experience in collecting vacancy data by using firm-based surveys. The Australian Bureau of Statistics currently takes a job vacancy quarterly survey which was first conducted in 1977 and completely revised in 1983 (see Australian Bureau of Statistics, 2007). National firm-based surveys were also conducted during the '70s and then interrupted in the United States and Canada. As already mentioned, in 2000 the US Bureau of Labor Statistics launched the JOLTS.¹⁰ Similarly, Statistics Canada has been coming out with the new annual Workplace and Employee Survey (WES) since 1999 (see Statistics Canada, 2007). Furthermore, in 2000 new infra-annual firm-based job vacancy surveys have been carried out by some single American states such as, Florida, Colorado, Texas, Massachusetts, Nebraska and Minnesota.

⁷ Regulation (EC) No 453/2008 of the European Parliament and of the Council of 23 April 2008 on quarterly statistics on Community job vacancies and implementing ones.

⁸ With the exception of Italy where a help wanted advertising index is produced by the Isfol-Csa since 1980.

⁹ Two of them based, respectively, on advertisements placed in major metropolitan newspapers and internet advertisements carried on selected employment internet sites (produced by the Australia and New Zealand Banking Group); the other three (by the Department of Employment, Workplace Relations and Small Business) based, respectively, on counts of newspaper advertisements for skilled vacancies (Skilled Vacancies Index), internet advertisements for ICT vacancies on selected employment internet sites (ICT Vacancies Index) and internet advertisements for job vacancies on the Australian Job Search employment internet site (Vacancies on AJS series).

¹⁰ For a detailed description of the JOLTS, see <http://www.bls.gov/jlt/>.

2.1 Current Job Vacancy Surveys in Europe: A Short Comparison

The European regulation states that the quarterly job vacancy statistics have to cover the population of all firms with at least one employee in all economic activities, with the exclusion of the activities of households as employers and those of extraterritorial organisations and bodies¹¹ (that is, sections A to S of Nace Rev. 2 classification).

Currently, not all member states are satisfying this requirement.¹² In particular, the Italian and French surveys cover only firms with at least 10 employees. Furthermore, the Italian survey covers businesses in industry and private services, with the exclusion of all public services and also of private educational and health services, i.e. it covers from sections B to N of the Nace Rev. 2 classification. The educational and health services, both public and private, are also excluded by the German survey which does not cover mining and quarrying, and electricity, gas and water supply, i.e. it covers section C, sections from F to O and sections from R to S. The French and Portuguese surveys exclude public administration, covering sections from B to N and from P to S. The coverage of the three non-EU surveys considered is similar to that of sections from B to S of the Nace Rev. 2 classification, although the armed forces have been excluded by the Australian survey and public administration by the Canadians.

The EU regulation does not impose one or more reference dates for vacancies within the quarter. Most of the member states, Bulgaria, Cyprus, Estonia, Finland, France, Greece, Hungary, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Romania, Spain and also the Australian and JOLTS surveys, collect job vacancy data only on one single date in the reference period, usually the last day of the quarter or month. Other countries such as, Belgium, the Czech Republic, Luxembourg, Slovakia, Slovenia, Sweden and the United Kingdom, have two other dates within the quarter, e.g. the middle Wednesday of each month in Sweden or the Friday in day 2-8 of each month in the United Kingdom. The German survey is carried out on a continuous basis over a period of two months from the second half of the first month to the first half of the last month of the quarter.

Also the job vacancy definitions used in each survey differ from that included in the EU regulation, in which job vacancies are defined as paid posts, existing or newly created, which are unoccupied, or about to become vacant in cases where (i) the employer is taking active steps and is prepared to take further steps to find a suitable candidate from outside the firm concerned; (ii) the employer intends to fill the vacancy either immediately or within a specific period of time.

The Swedish and Finnish surveys, for instance, collect job vacancies defined as both job openings or recruitment processes and unfilled jobs as a measure of the unmet labour demand. In the Spanish survey, and also in the Australian one, the definition includes only job vacancies to be filled immediately as proxy of the unmet labour demand. The JOLTS measures unmet labour demand, although in this survey unfilled jobs are called job openings. The Spanish and the Dutch surveys include also purely internal job vacancies and not only vacancies for which the employer is looking for a suitable candidate from outside the firm. The Italian survey excludes job vacancies for managers. Job vacancies for which a

¹¹ Covering agriculture, forestry and fishing activities (section A of the Nace Rev. 2 classification) is considered as optional.

¹² For a more detailed description of the methodology applied by each country, see http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/jvs_q_esms.htm.

suitable candidate has already been recruited, but has yet to start working are considered to be still vacant in the Italian survey, while they are not in the British and Slovenian surveys, and also in the Australian and the US ones.

Regarding the variables measured by the existing EU surveys, only the Spanish and the Dutch quarterly surveys collect information also on the flows of vacancies, besides that on the stocks. In particular, they collect data on job vacancies filled, cancelled and opened in the reference quarter.

Information about main job vacancy characteristics concerning the firm's economic activity, size in terms of number of employees and geographical area is generally provided by the current surveys. Information on hard-to-fill job vacancies is also frequently asked in the different surveys. Sometimes data on immediately available job vacancies are acquired like in the Italian and German questionnaire. In particular, in the German one a distinction is made between short-term job vacancies, to be filled immediately or during the next three months, and long-term vacancies, to be filled after the next three months. In the German survey, vacancies are differentiated also by occupation and qualification, i.e. university degree or not. Similarly, the Polish survey collects information on job vacancies disaggregated by occupation and level of education and on the newly created job vacancies. In the Portuguese survey job vacancies are also broken down by occupation.

Information on job vacancy duration is rarely collected by the existing EU and non-EU surveys. The information is currently provided by the Dutch and German annual surveys and by some of the American state surveys, e.g. the Minnesota¹³ job vacancy survey.

The quarterly job vacancy statistics that will be produced according to the EU regulation will be useful mainly as short term indicators. As such, they will be available only at a relatively high level of aggregation with sections of the NACE in force. But they are going to be available in as short a time as possible after the end of the reference period which is around 45 days for the entire reference population and around 70 days for the economic activity sections.

So far, the demand for more structural information on job vacancies, as expressed in particular by the EU Commission, has yet to produce a regulation on harmonized annual statistics and therefore remains largely unsatisfied. Some member states, however, are already carrying out annual surveys on a regular basis, e.g. Bulgaria, Germany, Spain, Latvia, Lithuania, the Netherlands, Poland, Romania, Slovakia and Slovenia. Some of the annual surveys have preceded the infra-annual one. For example, in the Netherlands the annual job vacancy survey started in 1976, long before the quarterly one started in 1988. Germany has regularly carried out the annual job vacancy survey since 1989 during the fourth quarter of each year, while the additional quarterly survey has come out only since 2006, in the first, second and third quarters.

Figure 1 shows the job vacancy rates in the European countries currently producing and transmitting job vacancy statistics for the latest quarter published by Eurostat.

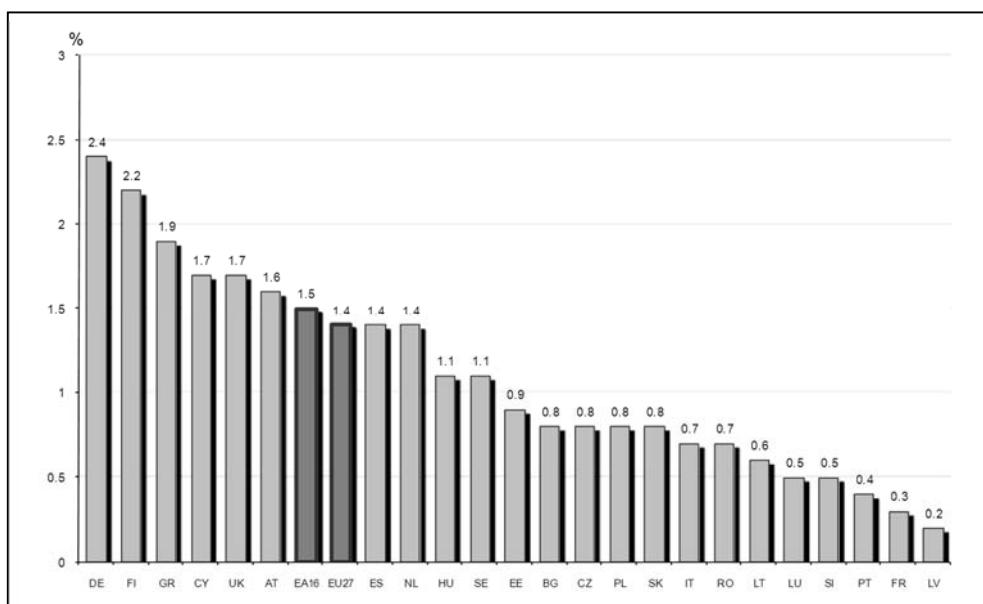
The job vacancy rates are quite different across the European countries. For example, the Italian figure is half the EU(27) and EA(16) aggregates. In particular, 0.7 job vacancies out of 100 job positions, occupied or vacant, are registered in Italy with respect to 1.4% and 1.5% in the EU(27) and EA(16) aggregates. A job vacancy rate far from the EU aggregates and less than half of the Italian one is observed in France (0.3%), which has the lowest rate

¹³ For further details on the Minnesota job vacancy survey, see http://www.positivelyminnesota.com/Data_Publications/Data/All_Data_Tools/Job_Vacancy_Survey.aspx.

together with Latvia (0.2%). Spain and the Netherlands (1.4%) are well above France and Italy with a job vacancy rate equal to the EU(27) average. Above EU average rates are observed in Germany, Finland, Greece, Cyprus, the United Kingdom and Austria. In particular, Germany (2.4%) and Finland (2.2%) have the highest job vacancy rates.

The differences can be explained by both the different structural characteristics of the labour markets in the various countries and the above described different characteristics of the EU surveys. In particular, the differences in the population coverage of the indicator and the less than complete harmonization in the measurement of job vacancies and occupied posts, i.e. different reference dates or different number of reference dates within the quarter, and the differences in the applied job vacancy definitions, also may contribute to produce the observed discrepancies.

Figure 1 - Job Vacancy Rates in Europe - First Quarter 2010 (percentage values)



Source: Eurostat

3. Information Still Missing on Job Vacancies

In spite of the recent improvements in the production of the job vacancy statistics, some important parts of the recruitment statistics are yet to be covered.

The analysis of the ongoing surveys carried out in the previous section highlights the information on job vacancies which is still missing along with the lack of more structural information on job vacancies.

First, the information collected mainly regards the job vacancy stocks, while the flows, both inflows of new vacancies opened and outflows of vacancies filled or cancelled during the reference period, are collected only in the Spanish and the Dutch quarterly surveys.

Furthermore, the stock is generally collected on one specific date within the reference period with the exceptions of Belgium, the Czech Republic, Luxembourg, Slovakia Slovenia, Sweden, the United Kingdom and Germany, which use more reference dates for the vacancy stock. But, the point-in-time stock may not represent the openings of new job positions during the whole reference period due to possible unmeasured flows of new vacancies which are posted and filled within this period. Furthermore, the information on the stock alone is not sufficient to represent the job vacancy dynamics over the reference period. The stock could change only slightly or remain equal in size between the two reference dates when the inflow and outflow of vacancies fluctuate simultaneously in the same direction. Moreover, the choice of the date strongly influences the representativeness of the stock. For example, data could be highly influenced by the firm's hiring behaviour when using a specific reference date for job vacancy collection. Hence, the actual number of job vacancies could be over or under estimated.

Second, the information on unfilled job vacancies is still quite uncommon as compared to the job openings. In particular, job vacancies can be defined in terms of both unfilled positions and recruitment processes. In other words: “(...) *firms create vacancies in one sense (recruitment processes) in order to avoid vacancies in another sense (unfilled jobs)*” (Farm, 2010, p. 12). In order to highlight this distinction, vacancies as recruitment processes are usually called job openings, while vacancies as unmet labour demand are labelled as unfilled jobs. The definitions adopted by the recently launched job vacancy surveys mainly regard the concept of job openings and not that of unfilled jobs,¹⁴ which are collected only by the Swedish, Finnish and Spanish surveys and by the Australian and JOLTS ones.

Third, job vacancy duration is almost never collected except by the annual Dutch and German surveys and by some of the American state surveys.

Fourth, some basic facts concerning the connection between vacancies and hirings are still almost unknown. They pertain to the hirings without vacancies and vacancies without hirings.

There are several ways in which a hiring can occur without any preceding recruitment activity. For example, an employer might create a new position to hire an attractive candidate who suddenly becomes available or known. The hiring outcome is analogous to a discouraged worker who is not actively seeking work, but who accepts a job if a suitable one becomes available (see Gatto and Tronti, 2010). Then, there is no job vacancy which precedes hiring. Moreover, employers can hire someone they have previously engaged as an independent contractor, consultant, or temporary worker, while forgoing any active recruiting. It can be observed that even if a recruitment process precedes a hiring, it can sometimes be so short that the distinction between the recruitment process and the hiring is negligible. For example, some hirings are made more or less directly by recalling former employees. Hirings with negligible or non-existent recruitment processes before hiring are usually called instantaneous hirings (see Farm, 2005, 2010 and Davis et al., 2009). Even though the proportion of instantaneous hirings is not measured in the current job vacancy surveys, what information there is does suggest that not every hiring begins with a job vacancy, as shown, for example, by the Employment Opportunity Pilot Project surveys carried out in the United States in 1980 and 1982. In these surveys employers were asked questions about the hiring process for the most recently hired people. In the first survey, 28% responded that they did not recruit for the position (as reported in Farm, 2010).

¹⁴ Also the surveys carried out in the past, such as those discussed in NBER (1966), Muysken (1994) and Verhage et al. (1997), generally considered job openings.

The other issue which has received little attention is the fact that personnel searches do not always end successfully, resulting in job vacancies which are closed without being filled. There are several reasons, usually connected with the business cycle, for which vacancies may be closed. Employers with job vacancies may stop searching, apart from a possible “discouraged employer effect”, because part of the work has been contracted out or the financial economic situation of the firm has worsened. Firms can have difficulties in forecasting their labour demand and they realize that they have overestimated their needs. Some job vacancies may also be cancelled because firms realize that no recruitment is possible at the moment and that they have to solve their staffing problems by other means, e.g. reorganization and training followed by posting job vacancies which are easier to fill (see Verhage et al., 1997 and Farm, 2005, 2010). Unfortunately, there is very little information on cancelled job vacancies, particularly on firms’ reasons for cancelling job vacancies. Some sample surveys by the Public Employment Service in Sweden in the beginning of the 1990s suggest that the proportion of job vacancies which end in hiring is very high, and at least equal to 90% (as reported by Farm, 2010). Similarly, results by van Ours and Ridder (1992, p. 145) suggest that the job vacancies cancelled are a small percentages, somewhere around 4%.

Covering the vacancy information which is still missing would be an important step towards a better and fuller understanding of some basic facts on friction in job matching: *“If all hirings were instantaneous there would be no vacancies as measured in vacancy surveys. We can consequently interpret the number of vacancies as a summary measure of friction in terms of deviations from instantaneous hirings (...). A theory of vacancies only applies to deviations from instantaneous hirings, so it matters whether the proportion of non-instantaneous hirings is 100 per cent or 10 per cent”* (Farm, 2010, p. 2 and p. 20).

Beside the job vacancy rate, a summary measure of deviations from instantaneous hirings is the average recruitment time, T , as measured by V/H , where V denotes the stock of job vacancies, defined as ongoing recruitment processes, and H is the flow of hirings per period. Hence:¹⁵

$$V=HT \quad (1)$$

It can be observed that the average recruitment time is the inverse of the job-filling rate, H/V , also called vacancy yield which is *“a measure of success in generating hires”* (see, Davis et al., 2009, p. 34).

Furthermore, in the equation above the assumption that every hiring begins with a job vacancy is implicitly made. But, in general, it may be difficult to define and measure job vacancies for the instantaneous hirings, since they are characterized by a non-existent or negligible recruitment processes before. Hence, a more accurate estimation should take into account only the proportion of hirings preceded by job vacancy (b), as suggested by Farm (2010, p. 4):

$$V=bHT \quad (2)$$

Thus, a complementary sample survey regarding the duration of job vacancies would give not only valuable information about the duration of job vacancies as distinct from the average duration of recruitment, but also a possibility to estimate the proportion of instantaneous hirings from equation (2).

¹⁵ For instance, in Abraham (1983) and Jackman et al. (1989) attempts are made to estimate the total number of job vacancies from the total number of hirings per period and the average duration of job vacancies for some part of the economy according to equation (1).

However, equation (2) is not yet complete since it presupposes that all vacancies end with hirings, so that bH measures the total inflow of job vacancies. Once again, a more accurate estimation should take into account only the proportion of non-cancelled vacancies (c),

$$cV=bHT \quad (3)$$

To summarize, collecting information on job vacancy duration, the proportion of non-instantaneous hirings and job vacancies cancelled would increase the set of possible measures of friction in job matching in terms of deviations from instantaneous hirings with respect to the job vacancy rate and the non-adjusted average duration of recruitment.

But how do deviations from instantaneous hirings affect employment? The additional information concerning the number of unfilled jobs is a measure of the direct effect of recruitment problems on employment. More precisely *“the time it takes to recruit workers may reduce employment by making the number of filled jobs (employees) less than the number of jobs. And the difference is the number of unfilled jobs.”* (Farm, 2010, p. 9).

Four main definitions of unfilled jobs, aimed at adequately measuring the unmet labour demand can be found in literature (see, Farm, 2003a for a detailed description and comparison of the following definitions). A traditional definition, “unoccupied job openings which are available immediately”, a definition which corresponds to the ILO-definition of unemployment, the classical definition, “unsatisfied labour demand”, and a definition suggested by Eurostat, “job openings which are available immediately”.

4. The Experimental Survey on Job Vacancy Flows and Duration

In this section the experimental survey on job vacancy flows and duration will be presented. This survey has been purposely designed and launched in order to measure those basic facts on friction in job matching which are still rarely or never covered by the current official surveys on job vacancies, as the investigation in the previous section has shown. Due to its experimental nature and to its characteristics, the survey is based on a very small sample of firms. It is aimed both at understanding if firms are able to provide data on these basic facts and, if so, at providing initial quantitative evidence on them.¹⁶

In particular, the experimental survey covers two main areas in which the recruitment statistics are still particularly lacking, not only in Italy where the recent Istat quarterly survey on job vacancies and hours worked provides new valuable short-term indicators for labour market analysis (see Istat, 2009a, 2009b). Unfortunately, the current Istat survey collects information only on the stock of vacancies, including details on hard-to-fill and immediately available vacancies, while it does not provide information on the flow of vacancies.

This is mainly due to the increase in the response burden for the firms that it should imply, given its periodicity and the collection of other variables in addition to job vacancies, considering hours worked, employees, hirings and separations. The experimental survey, similar to an *ad hoc* survey, focuses only on the recruitment and the hiring processes, for both of which an in-depth analysis has been carried out by collecting very

¹⁶ I have carried out the experimental survey for my PHD thesis in agreement with the Istat department in charge of the quarterly survey on job vacancies and hours worked, where I was employed as a research fellow. The aims of the experimental survey and the results to be obtained from it were also of interest for the Istat department since they were meant to provide insights for the Istat job vacancy survey.

detailed information. To this end, in the survey, firms with particular characteristics which would have enabled the exploration of the research objectives have been chosen by using a purposive sampling method.

The first area of interest of the experimental survey pertains to the connection between vacancies and hirings. Attempts have been made to highlight the extent to which hirings do not begin with job vacancies and job vacancies do not end in hirings and the time to fill a job vacancy successfully by measuring:

- hirings without vacancies;
- vacancies without hirings;
- job vacancy duration.

Besides these facts, the experimental survey focuses on some of the main issues which arise in measuring the job vacancy variable, on which, so far, very little information exists. Thus, the other area of interest considers the distinction between the concepts of job openings and unfilled jobs and between point-in-time stocks and flows of job vacancies. In addition to this, another two issues have been investigated: the possible recruiting practices, and then job vacancies, more difficult to gather; and the possible ways in which employers record information on job vacancies, if there exists a kind of job vacancy record-keeping which records each vacancy opened and closed in a period and the level of detail of the job vacancy characteristics which has been recorded.

The first two issues have already been dealt with in the previous section, while regarding the last two, it can be observed that the job vacancy variable is more difficult to be accurately measured compared to other variables generally collected in business surveys. Three main contributing factors can be taken into consideration.

First, the concept of job vacancy and the conditions required in the currently used job vacancy definitions could not be fully understood by firms. This could cause an underreporting of vacancies by the respondents to the job vacancy surveys.

In particular, firms could find it difficult to identify the active recruitment actions among their usual recruitment activities. The current job vacancy definitions, for example the EU regulation and the JOLTS definitions, require that active steps be taken by firms. For example, firms could not consider recalls of former employees to be an active step, unless instructed to do so. Similarly, they could not identify the examination of the curricula, which they generally receive and record in their database, aimed at filling specific job positions as active recruiting. Therefore, they could not report job vacancies, i.e. to have started recruitment processes, since they do not consider the two actions above as active recruitment steps. It is worthwhile to note that over the period from the first quarter 2004 to the second quarter 2008 the fraction of Italian firms with at least 10 employees in industry and private services with no reported vacancies at the end of each quarter averages 89% (see Istat, 2009a).

Second, differently from employment or hours worked variables, mainly recorded by the firm for administrative purposes, job vacancy information is generally not recorded in the firm information system: “*The principal difficulty is that employers do not keep records of vacancies comparable in accuracy or detail with their payroll record*” (Meyers and Creamer, 1967, p.2). First evidence seems to suggest that most of employers do not keep information on exactly when the recruitment process has started and ended, as shown by the preliminary tests of the questionnaires of the current Istat quarterly job vacancy survey and of its previous pilot survey (see Fivizzani et al., 2003).

Third, the less the job vacancy information is formally recorded by employers, the less the accuracy of the information collected when the time lag between the reference date for the job vacancy variable and the date in which it is actually collected increases. *“In fact, the nature of job vacancies characterized by volatility and the possibly informal way in which they leave track in the enterprise information system would suggest preferring a data collection closer to the reference date”* (Baldi et al., 2007, p.14).

Hence, the second area of interest of the experimental survey focuses on the measurement of the:

- number of job openings and unfilled jobs;
- point-in-time stock of vacancies, inflow of new vacancies and outflow of vacancies both for filling and cancelling.

Furthermore, qualitative information is also acquired which regards the:

- possible recruitment actions taken by the firm;
- possible ways in which firms record job vacancy information.

4.1 Sample and Questionnaire Design

The observation unit of the experimental survey is the firm. Due to the experimental nature of the survey, a small sample composed of 76 firms has been used. As already mentioned, a purposive sampling technique has been applied to select firms potentially able to provide the information required. As a frame, the list of respondents to the current Istat survey on job vacancies and hours worked in the fourth quarter 2007 has been considered.

In particular, a set of firms with the following characteristics has been selected:

- with at least one job vacancy at the end of the fourth quarter 2007 or one hiring during this quarter;
- belonging to the size class 50 to 499 employees;
- frequently respondent to the current Istat survey;
- whose economic activity is classified in “Manufacturing” and “Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods” (Ateco 2002 sections D and G);
- operating in the provinces of Milan, Venice, Padova, Treviso, Rome, Latina and Naples.

The first condition ensures the feasibility of the survey. The measurement of the variables of interest would be otherwise unfeasible in firms with no job vacancies and no hirings.

On the basis of the second condition small and very large firms have been excluded. Three factors have suggested pursuing this avenue. First, some very large firms with more than 500 employees can be reluctant to provide information on their job vacancies due to misplaced confidentiality concerns, both with respect to third parties and to workers of the concerned firm. Such difficulties have been actually encountered in some waves of the Istat job vacancy survey. Thus, in order to minimize the risk of non-response, these firms have been excluded. Second, a significant number of job vacancies could be more easily collected in medium-large firms, since the average number of job vacancies increases with the firms’ size (as shown in Baldi et al., 2007). Third, small firms generally use informal search channels more often. But, the more the channel used to recruit new employees is informal, the more the employers find difficulties in both recognizing the active recruitment actions among their usual activities and identifying the exact starting and ending dates.

Then, information on the life-cycle of job vacancies, i.e. their opening and closing dates, useful for measuring both job vacancy flows and duration, could more likely be acquired if medium-large firms were selected.

Following the third selection condition, firms responding in at least three out of five consecutive waves of the Istat job vacancy survey have been selected in order to minimize the non-response risk.

On the basis of the fourth condition, firms in only two economic activity sections have been selected, mainly due to the experimental nature of the survey and to the very limited resources for it to be carried out. Hence, sections D and G have been considered due to the following reasons. They are sections in which a sufficient number of firms could have been selected once the above mentioned selection conditions were applied. Moreover, they are sections in which information regarding job vacancy duration, as much as possible referred to different occupation, could have been more likely acquired.

Finally, considering firms which geographically differ, firms in the above mentioned provinces have been selected.

The target sample, defined as a set of firms with the above mentioned characteristics, is well distributed between the two economic activity sections considered (Table 1). However, taking into account the four classes and the three divisions identified, respectively, in section D and G according to a Pavitt-like classification and the Ateco 2002 classification, scale intensive (D2 Pavitt class), traditional firms (D4) and wholesale trade firms (division 51) account, on the whole, for 70% of the target sample. Respondent firms have been 22 of the 76 selected firms. An above average response rate is observed in section G. Hence, the composition of the respondent firms differs from that of the target sample in favour of this last section, which covers around 60% of the respondents.

Firms with 50-100 employees cover more than half of the target sample, while those with 100-300 account for less than 30%. The set of respondent firms is quite similarly distributed among the three size classes, even though firms with 100-300 employees increase their percentage shares because of an above average response rate. Firms in the province of Milan account for the largest percentage of both the target sample and the set of respondent firms (55% and 50%).

Information has been acquired by means of a thorough questionnaire suitable for occasional and *ad hoc* surveys. It is composed of 5 sections including, on the whole, 13 questions, mainly close-ended. Given the experimental nature of the survey and the very little information that exists on some of the facts studied, such as instantaneous hirings and cancelled job vacancies, the option to specify other possible circumstances which could have caused them, besides those suggested in the questionnaire, has been added to the corresponding questions. The reference period for the variables collected is the fourth quarter 2007.

Table 1 - Sample and Respondent Firms by the Economic Activity Sections, Size Classes and Provinces Selected

	Sample		Respondent Firms		Response Rate
	Number	% of Total Sample	Number	% of Total Respondents	
Economic Activity Section					
D- Manufacturing (a)	39	51.3	9	40.9	23.1
D1-Science Based	2	2.6	1	4.5	50.0
D2-Scale intensive	15	19.7	3	13.6	20.0
D3- Specialised Suppliers	6	7.9	2	9.1	33.3
D4- Traditional Firms	16	21.1	3	13.6	18.8
G- Wholesale and Retail Trade; Repair of Motor Vehicles, Motorcycles and Personal and Household Goods (b)	37	48.7	13	59.1	35.1
50-Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Automotive Fuel	4	5.3	3	13.6	75.0
51-Wholesale Trade and Commission Trade, except of Motor Vehicles and Motorcycles	22	28.9	7	31.8	31.8
52- Retail Trade, except of Motor Vehicles and Motorcycles; Repair of Personal and Household Goods	11	14.5	3	13.6	27.3
Total	76	100	22	100	28.9
Size Class					
50- 100	42	55.3	11	50.0	26.2
100- 300	21	27.6	8	36.4	38.1
300- 499	13	17.1	3	13.6	23.1
Total	76	100	22	100	28.9
Province					
Milan	42	55.3	11	50.0	26.2
Venice	8	10.5	3	13.6	37.5
Padova	7	9.2	2	9.1	28.6
Treviso	11	14.5	2	9.1	18.2
Rome	4	5.3	3	13.6	75.0
Latina	1	1.3	0	0.0	0.0
Naples	3	3.9	1	4.5	33.3
Total	76	100	22	100	28.9

Source: Experimental survey on job vacancy flows and duration

(a) Broken down by the four classes of the Pavitt-like classification.

(b) Broken down by the three divisions included in this section according to the Ateco 2002 classification.

The first section of the questionnaire contains the data identifying the firm.

The second section aims at collecting information on the characteristics of the recruitment process. Information is required regarding the different recruiting channels used and actions taken by the employers and on the priority they attribute to each. Besides the usual formal and informal recruiting methods like advertising in newspapers, word of mouth, etc., practices which firms could find difficult to identify as active steps, unless explicitly instructed to do so, have also been added, e.g. recalls of former employees and screening of the curricula. This section brings up two further questions. The first, if the firm keeps a job vacancy register and, then, the possible ways in which job vacancy information is registered, whether by using a specific database, paper documents or informally without any kind of registration. The second, if the information recorded allows for reconstructing the job vacancy opening and closing dates and the main characteristics and requirements of the corresponding job positions such as wage level, whether permanent or fixed-term, whether it concerns replacement demand or employment growth, skill level, level and type of education required, etc.

Job vacancies are the subject of the third section of the questionnaire.¹⁷ In particular, for each job vacancy still open at the end of the fourth quarter 2007, the following data are required: its opening date, i.e. when the firm has taken the first active steps to fill the corresponding job position, and its actual or supposed closing date; the firm's reasons for opening the job vacancy, e.g. expansion of the firm production or substitution of workers which have already left or still occupied the position; and if the job vacancy is immediately available, i.e. when a suitable candidate can start to work immediately or later than in the next three months. These last two questions are aimed at measuring the unmet labour demand on the basis of the unfilled jobs traditional definition (see section 3). In this section a further question requires information on job vacancies closed without being filled during the period from the end of the reference quarter to the date of interview. The question mainly focuses on the firm's reasons for cancelling job vacancies. It avoids asking all the above mentioned information also for each cancelled vacancy in order to contain the response burden for the firms. In particular, a first question asks if the firm has interrupted the search of new workers without finding a suitable candidate during that period. If the answer is yes, a further question asks how many cancelled job vacancies broken down by possible reasons. The following reasons have been suggested: the firm met difficulties in finding suitable candidates; the firm exaggerated its need for new workers; the general economic situation changed; the economic situation of the firm worsened and there was a reduction of the annual budget for hiring new workers; and job vacancies were filled by means of reorganization using internal employees. As already mentioned, firms were also asked to specify other possible reasons for withdrawing job vacancies from the labour market.

Hirings during the fourth quarter 2007 are the subject of the fourth section of the questionnaire. They correspond to the job vacancies filled during the reference quarter with the exception of hirings which have taken place without any recruiting efforts before. Therefore, the same data required in the previous section for each job vacancy still open at the end of the reference quarter are also asked for each job vacancy filled during the quarter. Moreover, as in the previous section, a further question asks how many cancelled

¹⁷ They have been defined as in the Istat current job vacancy survey questionnaire in which, according to the EU regulation definition, job vacancies are posts for which the employer had already taken active steps to find and hire suitable candidates from outside the firm and was ready to take further such steps, if needed. It can be noted that the same reference date, the last day of the reference quarter, has been used.

job vacancies broken down by firm's reasons for their cancellation. The last question of this section aims at measuring hirings without a prior vacancy. A first question asks whether during the reference quarter the firm hired new workers without doing any active recruitment efforts. If the answer is yes, a further question asks how many hirings took place without vacancies broken down by possible situations determining them. The following situations have been set up: attractive candidates suddenly contact the firm which then decides to hire them, even though the firm is not looking for new workers to hire; external institutions or organizations suggest new workers to hire; and internal offices, different from the personnel department, recommend new workers to hire. Firms were also required to specify other possible situations, beside those listed above, which could have implied instantaneous hirings.

In the final section of the questionnaire, firms have been asked to indicate whether they find it difficult to fill in the questionnaire and to specify the possible difficulties they may meet.

Firms were contacted by telephone to identify a possible reference person and to verify her/his willingness to respond to the survey questionnaire. To contain the response burden and facilitate the collaboration, firms could transmit the data by telephone, via e-mail or fax or through face-to-face interviews. After the data transmission, firms were contacted again by telephone to acquire the missing information. The need of further recalls was expected due to the kind of information required and its level of detail.

Firms were contacted during the months of February and March 2008, on the one hand, to facilitate the recall of the opening dates of vacancies both still open at the end of the reference quarter and filled during this quarter; on the other hand, to wait for a sufficient time to fill vacancies still open at the end of the reference quarter, so as to compute, as much as possible, completed job vacancy durations.

5. Measuring Job Vacancies: Some Preliminary Evidence

In the following sections, the results obtained in the two areas of interest of the experimental survey are discussed. The results are limited to the set of respondent firms and influenced by the characteristics of the selected firms, due to the non-random sampling method used to extract the sample. Even so, they provide initial measurements of some basic facts on friction in job matching which are still unknown and represent a first step for further surveys and analysis. Due to the preliminary nature of the results, special caution should be paid in interpreting and comparing them with those from other studies.

5.1 Do the Firms Record Highly Detailed Job Vacancy Information?

Most of the respondent firms (15 out of 22) formally record job vacancy information in their databases or on paper (Table 2). The result was somewhat foreseen, having excluded from the sample small firms with less than 50 employees. Furthermore, the fraction of firms which formally record job vacancy information increases in moving from the smallest to the largest size class. Among the firms which formally record job vacancy information, the majority (around 70%) use specific databases, approximately 2 out of 3 are large firms with an average of 200 employees. Paper documentation is mainly used by the smallest firms among those selected, with an average of 60 employees.

Table 2 - Firms by Size Class and Kind of Job Vacancy Information Recording

SIZE CLASS	Formal Recording			Informal Recording	Total
	Database	Paper	Total		
50 - 100	2	4	6	5	11
100- 300	6	0	6	2	8
300- 499	2	1	3	0	3
Total	10	5	15	7	22

Source: Experimental survey on job vacancy flows and duration

Regarding the job vacancy information which is recorded (Table 3), a large percentage of the respondent firms holds information on: the characteristics of the job position corresponding to the job vacancy, whether open-ended or fixed-term, part-time or full-time, wage level, etc.; the requirements that are posted on job applications in terms of skills, education level, previous experience, etc.; the firms' reasons for searching for new employees for that position; and when a suitable candidate could start to work, immediately or only later. This kind of data seems to be available not only in firms which formally record job vacancy information (e.g. around 50% of firms record the recruiting channels and 80% the kind of contract), but also in firms which keep track of job vacancy information only in informal ways (with a percentage ranging from a low of around 14% to a high of 40% depending on the kind of information).

Job vacancy opening date, when the firm takes the first active step to fill the position, and closing date, when the position has been filled or the vacancy cancelled, are available only in the respondent firms which formally record job vacancy information. In particular, around 1 out of 2 of these firms records opening and filling dates, while the cancellation date is recorded only by one of them. As expected, employers who keep track of job vacancy information only in an informal way were not able to provide these dates, mainly due to the difficulties they found trying to remember them since the dates were not recorded in their database or on paper.

Table 3 - Firms by Kind of Job Vacancy Information Recorded

KIND OF JOB VACANCY INFORMATION RECORDED	Formal Recording	Informal Recording	Total
Opening Date	7	0	7
Filling Date	8	0	8
Cancelling Date	1	0	1
Recruiting Channels	8	1	9
Contract (Open-Ended, Fixed Term, etc.)	12	3	15
Working Time (Full-Time or Part-Time)	9	3	12
Wage Level	8	3	11
Skill Level	12	3	15
Education Level	11	3	14
Previous Experience	11	2	13
Firm's Reasons for Recruiting New Employees	9	2	11
Availability of the Job Position	8	3	11
Total	15	7	22

Source: Experimental survey on job vacancy flows and duration

Note: The sum of firms by kind of information recorded exceeds the total number of firms which, respectively, formally and informally record job vacancy information, since each firm can register more information.

The results shown in the previous tables derive from the answers to the second section of the questionnaire of the experimental survey purposely designed to acquire this kind of information (see section 4.1 for the questionnaire description). However, positive evidence on job vacancy characteristics registered by the respondent firms also comes out as answers to the third and fourth sections of the questionnaire. In these sections firms are required to provide some of the characteristics considered in table 3, respectively for each job vacancy still open at the end of the fourth quarter 2007 and hiring during this quarter.

Almost all of the 22 respondent firms have been able to provide complete, by day, month and year, filling dates directly in the questionnaire.¹⁸ Furthermore, the majority of firms providing the supposed filling dates in a second step, during further recalls, were able to specify the actual dates, either because the recruitment processes had already ended in the meantime or the period left to the end was shorter than before and the filling dates were more easily foreseeable.

Half of the 22 respondent firms have also been able to provide complete opening dates directly in the questionnaire, while the remaining ones needed further recalls. Among these last firms, for example, five have been recalled because, in the questionnaire, they provided the month and year of the opening dates without specifying the days. Then, these firms were able to provide some further information, even if regarding only the sub-period within the month during which the first active step had been taken, which was during the first ten days of the month, at the beginning of the month, etc. Three firms did not provide the opening dates at all. During the following contacts, one of them answered that, in general, opening dates could be dated the week before the closing dates, while the other two were not able to specify the opening dates, since the employers hired someone they had previously engaged as an intern or temporary worker. These last hirings have been considered as hirings without vacancies as better explained in section 6.1.

The difference in the number of firms providing, respectively, complete opening and closing dates was somewhat expected. Complete filling dates should be more easily provided, also by firms which keep track of the job vacancy information only in informal ways, since the hiring dates can be used to date approximately the filling of the job vacancies.¹⁹ Complete opening dates can be provided by the employers purposely and formally recording such information, which is otherwise difficult to be remembered or reconstructed.

Data on firms' reasons for taking new active recruitment steps and on the availability of the job positions for which these steps have been taken, also required in the third and the fourth sections of the questionnaire, have been provided by all the respondent firms.

To summarize the difficulties found by the respondents in providing complete opening and closing dates, Table 4 shows the total number of job vacancies collected and those for which it was, to some extent, difficult to obtain these dates, broken down by job vacancies still open at the end of the fourth quarter 2007 and job vacancies filled during the same quarter. At least for the firms respondent to the experimental survey, it seems feasible to collect job vacancy opening and closing dates. Job vacancies for which opening dates were

¹⁸ It can be observed that most of the firms reporting to not record job vacancy closing dates answered the questions requiring these dates in the third and fourth sections of the questionnaire.

¹⁹ The vacancy closing and hiring dates do not necessarily correspond. A job vacancy could be closed because a suitable candidate has been found, but she/he could sign the hiring contract only later. Furthermore, the hiring date could not be the same as the date in which the new worker actually starts to work.

not directly reported in the questionnaire account for 24% of all the 116 job vacancies collected, excluding job vacancies cancelled.²⁰ However, during the further recalls the employers were able to provide information useful for deducing complete opening dates also for this fraction of vacancies. Vacancies with supposed closing dates for which firms were not able to provide the actual closing dates account for around 9% of the job vacancies collected.

Table 4 - Job Vacancies Collected and Job Vacancies with Deduced Opening Dates and with Missing Closing Dates

	Job Vacancies with Deduced Opening Dates	Job Vacancies with Supposed Closing Dates	Total Job Vacancies Collected
Stock of Job Vacancies Still Open at the End of the 4 th Quarter 2007	19	10	52
Flow of Job Vacancies Filled in the 4 th Quarter 2007	9	0	64
Flow of Job Vacancies Cancelled in the 4 th Quarter 2007	-	-	8
Total	28	10	124

Source: Experimental survey on job vacancy flows and duration

As further positive evidence regarding the possibility to collect detailed information on job vacancy characteristics, it can also be observed that more than 70% of the respondent firms believe it to be feasible, and also easy, to provide the data required in the questionnaire of the experimental survey as the answers to the last section of the questionnaire have shown.

5.2 Recruitment Practices and Job Vacancies Difficult to be Captured

This section focuses on the possible difficulties that some employers might find in considering some of their usual recruiting methods as active recruiting steps and, then, in reporting to have opened job vacancies. In the job vacancy definitions further instructions define the active recruiting steps. They usually include: advertising the vacancy in the media, for example, internet, newspapers, etc.; contacting private employment agencies/head hunters; notifying the job vacancy to the public employment services networking; or word of mouth; accepting job applications; interviewing or selecting possible candidates.

Vacancies for which non-active recruiting steps have been taken by the employers are difficult to be captured by the current measurements of job vacancies. At the aggregate level, this could have a negative impact on the number of firms with no reported vacancies.

The results obtained by the experimental survey show that (Table 5) half of the respondent firms often use the examination of the curricula available in their database to cover specific job positions, which is not included among the active steps of the job vacancy definitions. It can be observed that the analysis of the curricula should not actually represent a recruiting step, if they have been collected by means of another active step, such

²⁰ For the cancelled job vacancies the opening and closing dates are not required in the questionnaire (see section 4.1).

as by advertising in newspaper, taken by the firm to cover the same job positions for which the curricula have been analysed. But, this is not the case for the firms which answered using the screening of the curricula as recruiting practice in the experimental survey.

Recalls of former employees, also not explicitly included in the job vacancy definitions, seem to be rarely used by the respondent firms. This was somewhat expected, since the selected sample does not include seasonal firms.

The other two informal search channels considered, contacting people whom the firm already knows and using ‘word of mouth’, are used with medium to high priority by more than 30% of the respondent firms. This result is quite high considering that the selected sample excludes small firms.

Among the formal search channels, advertising in the media and contacting private employment agencies are used with a quite high priority by half of the respondent firms. The result on the high use of these formal recruiting channels by the respondents was expected due to the selection of medium-large firms. Formal channels are generally more expensive than the informal ones and, then, often beyond the reach of small firms. Finally, notifying to the public employment services is used with minimum priority by the majority of the respondent firms.

Table 5 - Firms by Order of Priority with which They Use the Different Recruiting Methods

Priority	Formal Recruiting Channels			Informal Recruiting Channels			Recruiting Actions		
	Advertising in the Media	Contacting Private Employment Agencies	Notifying to the Public Employment Services	Word of Mouth	Contacting Known People	Recalls of Former Employees	Accepting Job Applications	Interviewing Candidates	Analysis of the Curricula
Maximum	1	0	0	0	1	0	0	11	0
High	5	4	0	2	1	0	9	6	11
Medium	5	7	2	6	6	1	6	0	6
Low	4	6	5	8	5	8	2	0	2
Minimum	7	5	15	6	9	13	5	5	3
Total	22	22	22	22	22	22	22	22	22

Source: Experimental survey on job vacancy flows and duration

5.3 Job Openings and Unfilled jobs

Evidence regarding the distinction between the two vacancy concepts, recruitment processes, job openings, and unmet labour demand, unfilled jobs, also comes out from the experimental survey. In particular, in the experimental survey, job openings are measured using the current Istat job vacancy definition, while unfilled jobs are measured according to the traditional definition “unoccupied job openings which are available immediately” (see section 3). According to the Swedish vacancy survey, which measures not only job openings, but also unfilled jobs by using the traditional definition as specified above, evidence arises out of unfilled jobs which account for a significant percentage. They average 40% of all vacancies in the private sector over the period 2000-2009.

Job vacancies which represent unmet labour demand account for a large percentage of all the vacancies reported by the firms respondent to the experimental survey (about 54%). In particular, of the 52 vacancies existing at the end of the fourth quarter 2007 (see Table 4), 28 comply with the requirements of the above traditional definition. These vacancies are mostly

new job positions created in order to expand the firm production. Only 4 of the total unfilled jobs are already existing job positions for which the separations of workers occupying them have not been anticipated and then, the replacements have not been made before the corresponding positions became unfilled.

5.4 Stock-Flow Distinction in the Job Vacancy Variable

The nature of job vacancies characterized by volatility and the possibly informal way in which they leave traces in the firm information system suggest taking into account two other problems which arise when measuring this variable: the distinction between point-in-time stocks and monthly or quarterly flows and the time between the reference and the collection dates.

A data collection near the reference date should be preferred in order to facilitate firms in reconstructing the number of job vacancies on the reference date (as suggested in Baldi et al., 2007), above all for firms recording job vacancy information only in informal ways.

In the following, the results obtained by the experimental survey useful for assessing the representativeness of the point-in-time stock will be presented. Table 6 shows the components of job vacancy total inflows and outflows observed in the set of respondent firms in the fourth quarter 2007. They have been computed by using the opening and closing dates of both job vacancies still open at the end of the reference quarter and vacancies filled during this quarter.

Being the opening and closing dates of the job vacancies cancelled not required in the questionnaire, which instead focuses on the reasons for cancelling job vacancies, the number of new vacancies opened in the reference quarter and cancelled in the same quarter has been estimated by applying the overall ratio between cancelled and filled vacancies, irrespectively of vacancy opening dates, to the new vacancies opened and filled in the reference quarter. The number of vacancies opened before the reference quarter and cancelled in this quarter has been obtained as the difference.

Besides the stock of job vacancies at the end of the fourth quarter 2007, table 6 also shows the stock at the end of the third quarter 2007, derived from the following quarterly equation of motion for the vacancy stock:

$$V_t = V_{t-1} + I_{t-1,t} - (F_{t-1,t} + C_{t-1,t}) \quad (4)$$

where V_t denotes the stock of job vacancies at the end of the fourth quarter 2007; $I_{t-1,t}$ the inflow of new vacancies opened in the fourth quarter 2007 and unfilled until the end of the quarter; $F_{t-1,t}$ and $C_{t-1,t}$ the outflow of vacancies opened before the fourth quarter and, respectively, filled and cancelled in the fourth quarter.

Each quarter, the stock of vacancies evolves in three ways. First, an inflow of new vacancies increases the stock. Second, hires deplete the stock. Third, some vacancies close without being filled, also depleting the stock.

In the above equation the inflow of new vacancies does not include new vacancies posted and filled or cancelled within the reference quarter (also listed in Table 6), since they do not contribute to producing the observed vacancy stock at the end of this quarter, being closed before then. Analogously, the depletion of vacancies during the reference quarter only regards vacancies which already existed at the end of the previous quarter, while vacancies posted and filled or cancelled within the reference quarter are excluded since they did not exist yet at the end of the previous quarter.

The results obtained show that for the restricted set of respondent firms the inflow of new vacancies in the fourth quarter 2007 is 1.94% and the outflow is 1.99% of employment, quite larger than the vacancy stock at the end of the quarter equal to 1.44%. The selection applied to extract the sample could have contributed to producing inflows and outflows of vacancies which significantly exceed the stock. For example, they could depend on the selection of firms with at least one job vacancy or hiring in the reference period and, then, with a minimum level of job and worker turnover.

Evidence of flows exceeding the stock comes out from the Netherlands quarterly survey which collects this kind of information. Inflows and outflows exceed the stock by about 30% on the average over the period 2000-2008.

Table 6 - Stocks, Inflows and Outflows of Job Vacancies

	Level	Percent of Employment
Stock of Job Vacancies at the End of 3 th Quarter 2007	54*	1.49
Stock of Job Vacancies at the End of 4 th Quarter 2007	52	1.44
Inflow of Job Vacancies: Job Vacancies Opened in the 4 th Quarter 2007	70	1.94
<i>Vacancies Opened in the quarter and Unfilled until the end of the quarter</i>	43	1.19
<i>Vacancies Opened and Filled in the quarter</i>	24	0.66
<i>Vacancies Opened and Cancelled in the quarter</i>	3*	0.08
Outflow of Job Vacancies: Job Vacancies Closed in the 4 th Quarter 2007	72	1.99
Job Vacancies Filled	64	1.77
<i>Vacancies Opened and Filled in the quarter</i>	24	0.66
<i>Vacancies Opened before the quarter and Filled in the quarter</i>	40	1.11
Job Vacancies Cancelled	8	0.22
<i>Vacancies Opened and Cancelled in the quarter</i>	3*	0.08
<i>Vacancies Opened before the quarter and Cancelled in the quarter</i>	5*	0.14

Source: Experimental survey on job vacancies flows and duration

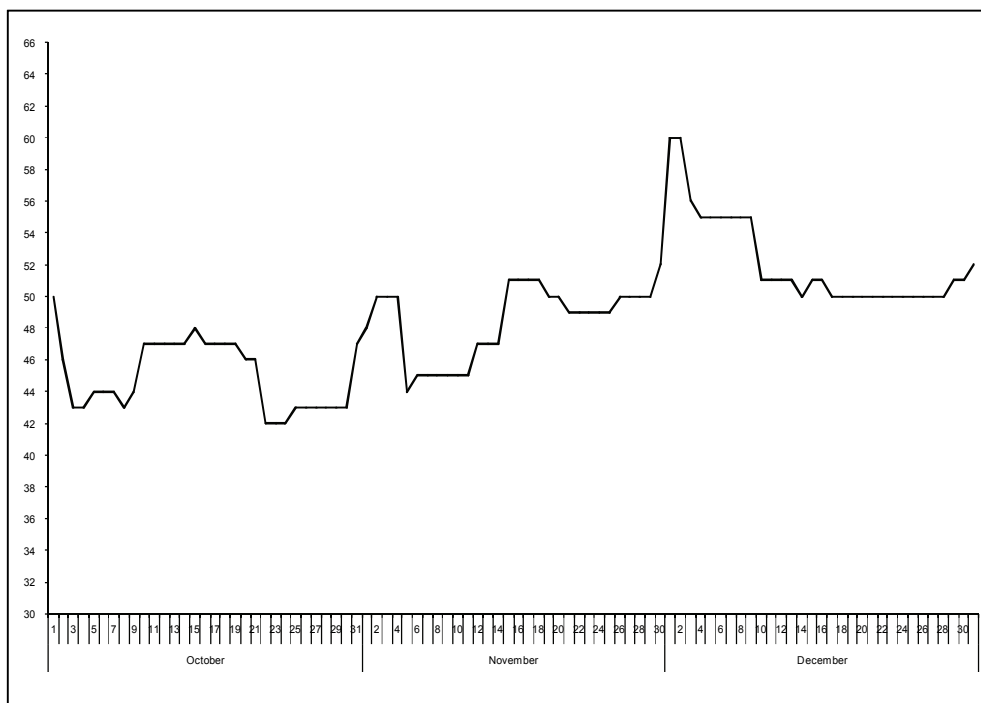
(*) Estimated as described in the text.

It can be observed that the higher the level of the vacancy inflows and outflows within the quarter, the lower the representativeness of the vacancies stock at a specific point-in-time of the quarter. Beside the level of the flows, their composition also provides some useful information for assessing the representativeness of the point-in-time vacancy stock. Taking into account the point-in-time stock at the end of the reference quarter, it necessarily implies that an unmeasured flow of new vacancies exists. In particular, as already mentioned, the flow of new vacancies posted and closed, for filling or cancelling, within the quarter is unmeasured by the stock at the end of the quarter. This component accounts for a significant percentage of the total flows of new vacancies which is slightly below 40%, while the flow of new vacancies remaining unfilled at the end of the quarter accounts for 60% (Table 6).

Also the choice of the reference date accounts for the representativeness of the point-in-time vacancy stock. The information collected in the experimental survey on the opening and closing dates has made it possible to compute the stocks of job vacancies on each day of the fourth quarter 2007 (see Figure 2). There is a considerable variation of the stocks across the different days of the reference quarter. In particular, the stocks range from a low

of 42 (at 22-24 October 2007) to a high of 60 job vacancies (at 1-2 December 2007). Moreover, the daily vacancy stock series shows an increasing trend in moving from October to December with monthly averages growing from 45, to 48 and to 52. Furthermore, looking at the daily dynamics of the stock, it seems that, within each month, the stock reaches the maximum at the beginning of the month, then it markedly declines and increases during the middle of the month. Next, it decreases and then increases again at the end of the month, although in the month of December the increase in the middle of the month does not appear. Therefore, due to the above mentioned facts on both the observed trend within the quarter and the dynamics within the month, the stock at the end of the reference quarter is 7% higher than the average daily stock in the quarter. In terms of the job vacancy rate measured as the number of vacancies reported at the end of the fourth quarter 2007 divided by the sum of vacancies and the simple average of employment between the third and fourth quarter 2007, the above difference inflates the vacancy rate at the end of quarter (1.42, see Table 7) with respect to the average daily job vacancy rate in the quarter (1.32%). The discrepancy of 0.1 percentage points between the two rates is not at all insignificant given the low level of the job vacancy rate.

Figure 2 - Daily Job Vacancy Stocks in the Fourth Quarter 2007



Source: Experimental survey on job vacancy flows and duration

6. Job Vacancies and Their Connection to Hirings: Some Preliminary Evidence

6.1 Hirings without Vacancies and Vacancies without Hirings

On the basis of the experimental survey we get the result that a substantial fraction of all hirings observed in the respondent firms seems to be outside the standard matching framework (17%). In particular, out of the 77 hirings reported by the respondents, 13 have been occurred without a prior vacancy. They account for 0.4% of the employment in the respondent firms.

The selection applied to extract the sample could have influenced the observed fraction of hirings without vacancies. Davis et al. (2009) using the JOLTS data find evidence that, not only a sizeable fraction of hires occur outside a standard framework of worker recruitment. Their analysis indicates that more than 1 in 6 hires occur without benefit of a vacancy, but also that the fraction of hires without a vacancy decreases systematically with employer size. In particular, they estimate that 14% of hirings take place without vacancies at firms with 50-250 employees, compared, for example, to 30% at firms with 0-9 employees and to about 5% at firms with 1,000 or more employees. Hence, our evidence also reflects the fact that among the selected firms, even if small firms are excluded, firms which do not exceed 100 employees account for 50% (as shown in Table 1).

The answers given by respondent firms to the questions on instantaneous hirings have also widened the set of the possible reasons for them with respect to those suggested in the questionnaire.

In particular, one out of the five firms which reported hirings without vacancies replied that the hirings had occurred because new employees were proposed by internal offices different from the personnel department. This was one of the possible items included in the questionnaire. During the further recalls better explanations of the reasons for this kind of instantaneous hirings have been obtained. The employer explained that these hirings generally take place since new job positions are created to hire attractive candidates recommended by the employees already working in the firm.

Another firm replied that instantaneous hirings occurred because the employer hired someone who had already been working for the firm although she/he was engaged by an external supplying firm.

Hirings that occur without vacancies were also reported by two other firms where the employers hired someone they had previously engaged, respectively, as a temporary worker and an intern.

The last firm reporting instantaneous hirings explained that its hiring process generally occurs without a prior vacancy mainly due to the kind of activities carried out, i.e. demolitions, decontaminations and reutilizations. In particular, for this firm the need for workers to be employed in the different scrap yards can suddenly arise. Therefore, new employees are generally recruited from an already established pool of former workers which the firm usually turns to without any additional and time-consuming recruitment effort, so that new employees are hired also in the same day in which such needs appear.

The information provided by the respondent firms highlights that, beside hirings not preceded by any active recruiting activities at all, hirings which are preceded by a recruitment process which is so short that the distinction between the recruitment and the

hiring process is negligible, also exist, in particular as explained by the last firm reporting instantaneous hirings. Since such vacancies, i.e. vacancies with negligible duration, are more difficult to be captured, it is likely that they are not measured in current job vacancy surveys.

Finally, one employer reported that even though instantaneous hirings did not occur in the fourth quarter 2007, they would have probably taken place in the following quarters. Due to the expansion of its production, this firm was always looking for new workers to hire. Hence, new job positions would be created to hire attractive candidates who suddenly became available or known.

Vacancies without hirings which are withdrawn from the market without being filled also appear in the experimental survey. They account for a significant percentage (11%) of all the vacancies closed by filling or cancelling by the respondent firms during the reference quarter. In particular, of all the 72 vacancies closed by the respondent firms, 8 are cancelled vacancies (see Table 6). Furthermore, job vacancies opened before the fourth quarter 2007 and cancelled in this quarter account for 9% of total vacancy stock at the end of the third quarter 2007. Regarding the firms' reasons for cancelling job vacancies, three firms responded that they had met difficulties in finding suitable candidates for the opened job positions while two others, respectively, answered that the need for new workers had been overestimated and then, consequently reduced, and that job vacancies had been filled by means of a reorganization using internal employees.

Recent evidence suggests that cancelled vacancies are quite common. UK vacancy data from the Office of National Statistics show that the proportion of all vacancies notified to the public employment service that are subsequently cancelled varied between 20% and 30% over the period 1985-2001 (see Andrews et al., 2008). Machin (2003) noted that a substantial proportion of these cancelled vacancies are regarded by employers as no longer existing. Also Andrews et al. (2008) provide some evidence that many cancelled vacancies are actually withdrawn from the market and do they not merely represent employers filling their vacancies by using other search strategies.

6.2 The Enlarged Set of Measures of Friction Including Vacancy Duration and Proportion of Non-Instantaneous Hirings

This section illustrates the enlarged set of friction measurements in terms of deviations from instantaneous hirings (discussed in section 3) with data from the experimental survey.

The considered measures of friction include not only the job vacancy rate and the estimated average duration of recruitment, obtained by inverting the vacancy yield, but also the proportion of non-instantaneous hirings and the job vacancy duration, i.e. the mean number of days required to fill an open job position. These last two quantities are not yet directly observed in the current job vacancy surveys with only very few exceptions regarding duration. Furthermore, besides the vacancy duration, the information collected also uncovers several other interesting quantities which pertain to the job vacancy daily process: the daily job vacancy rate, the daily job-filling rate and the daily flow of new vacancies.

As already mentioned, the job vacancy rate in the set of respondent firms was around 1.4% in the fourth quarter 2007, i.e. the respondent firms opened in this quarter 1.4 job vacancies per 100 job positions both occupied and vacant. As expected, this rate is quite above that for the total national economy coming from the current Istat quarterly survey (1.1%, see Istat, 2009b) due to both the selection of firms with 50-499 employees and with

at least one job vacancy or hiring. First, the Istat job vacancy rate includes also firms with no reported vacancies at the end of the reference quarters. This contributes to lower the rate because by adding these firms the denominator increases while the numerator remains unchanged. Second, the job vacancy rate within the firms with job vacancies decreases with firm size and above average job vacancy rates have been observed from firms with 5-10 to those with 50-100 employees (as shown in Istat, 2007). As already mentioned, the respondent firms in this last size class account for 50% of the total respondents.

Table 7 also reports the vacancy yield obtained by dividing the flow of hirings during the reference quarter (H_t) by the stock of vacancies at the end of the previous quarter (V_{t-1}). The respondent firms have a vacancy yield in the order of around 1.4 hirings per vacancy in the reference quarter.

The implied average recruitment time, according to equation (1), is around 64 days.

The selection applied to extract the sample contributes also to produce the observed vacancy yield and the implied average recruitment time, given that there are considerable variations across the employer size classes of the vacancy yield, as shown in the study of Davis et al. (2009). In particular, in this study, evidence has been found that the vacancy yield falls with firm size. For example, it falls by half in moving from firms with 50-250 employees to those with more than 1,000.

But the vacancy yield, and the implied average recruitment time, partly reflect the flow of hirings without vacancies. This flow contributes to inflate the vacancy yield and to reduce the average recruitment time, being these hirings not preceded by vacancies. On the contrary, the vacancy yield is depleted by the flow of cancelled job vacancies, being these vacancies not followed by hirings.

The adjusted vacancy yield obtained excluding the two above mentioned components, i.e. taking into account only non-instantaneous hirings and non-cancelled vacancies, bH and cV in equation (3), on the whole, decreases. The adjustment on the vacancy yield eliminates the inflating effect of the instantaneous hirings, in this case more significant with respect to the depleting effect of the cancelled vacancies.

The estimated average recruitment time implied by the adjusted vacancy yield is 70 days, 6 days higher than that estimated without excluding the two components.

Table 7 also shows the observed proportion of non-instantaneous hirings. In the set of respondent firms the fraction of hirings that are inside the standard matching framework is relatively large. They account for 83% of all hirings reported by the respondents.

Moreover, the job vacancy duration is presented in table 7. It averages around 76 days and has been computed as the average number of days required to fill the 116 job vacancies reported, on the whole, by the respondent firms during the reference quarter (see also Table 4). In addition to this, the average duration of 118 vacancies including also two vacancies corresponding to hirings with negligible recruitment processes before hiring is shown. The duration including “vacancies with negligible duration” averages around 1 day less the duration observed if such vacancies are unknown like they are in the current job vacancy surveys which usually do not capture them.

These average durations do not include the observed cancelled vacancies,²¹ for which it is likely that durations would be even longer than the average, since they are mainly hard-to-fill vacancies as shown in section 6.1. The duration of job vacancies for which firms

²¹ Cancelled vacancies are excluded from both durations, since their opening and closing dates have not been collected.

meet difficulties in recruiting a suitable candidate is particularly long and more than a quarter (around 4 months) as shown by the results of the Excelsior survey (see Unioncamere Ministero del Lavoro, 2007).

Coherently with the evidence in table 7 of vacancies lasting for less than a quarter, the analysis of flows in table 6 shows that most of the job vacancies observed at the end of the reference quarter were posted within the same quarter. In particular, job vacancies posted during the reference quarter which remain unfilled until its end account for around 80% of the total stock of job vacancies on this date.

The observed average durations are even longer than the estimated average recruitment time. It can be observed that, as expected according to equation (3), the adjusted estimated average recruitment time is more similar to the observed duration than the non-adjusted one.

But, the results of relatively long durations go against what seems to be a stylized fact, namely that *“the average completed duration of a vacancy is in most cases under a month”* (Farm, 2010, p. 8 and Petrongolo and Pissarides, 2001, p. 421).

For example, among the surveys collecting information on vacancy duration, the Minnesota job vacancy survey has shown that for the fourth quarter 2009 job vacancies open less than 30 days account for 58%.

Longer durations arise from the annual Dutch job vacancy survey. In particular, over the 2000-2006 period the percentage of job vacancies lasting less than one month varied between 20-30%; the percentage with a duration between one and three months between 30-40%; while the share of job vacancies open for a quarter or more fell between 40-50%.

The differences between the durations from the two surveys can be both explained by the different structural characteristics of the two labour markets and by the different characteristics of the surveys (as described in section 2.1).

In Italy the only information on job vacancy duration is the above mentioned regarding the job positions for which firms meet difficulties in recruiting a suitable candidate (see Unioncamere Ministero del Lavoro, 2007).

Regarding the results of the experimental survey, the characteristic of the selected firms in terms of the number of employees could have affected the duration observed, to the extent that large firms are more bureaucratic in their hiring process than the smaller ones (as Abraham, 1983, suggests). Furthermore, as shown in section 5.2 the respondent firms very often use formal search channels, in particular advertising and contacting private employment agencies. This could have also influenced the duration observed, given that using informal search channels seems to reduce job vacancy duration, while using public or private employment agencies or putting advertisements in newspaper seems to increase it (as, for instance, Gorter et al., 1996, Gorter and van Ommerem, 1999 and Devaro, 2001, 2005 show).

Moving from the quarterly to the daily framework, table 7 and figure 3 show, at a daily level, some of the quantities analysed so far only at a quarterly level.

Similar to the vacancy yield, the daily job-filling rate is defined as the hirings reported on day s in quarter t divided by the vacancy stock reported on the previous day ($h_{s,t}/v_{s-1,t}$).

An average job-filling rate in the quarter equal to 1.7% per day is observed in the respondent firms (Table 7). The above considerations on the effects of the selection hold, since the job-filling rate exhibits the same strong patterns as the vacancy yield (as shown in Davis et al., 2009). Hence, it declines with employer size, falling by more than half in moving from the smallest to the largest firms. Figure 3 shows the daily job-

filling rate and the daily flow of new vacancies in comparison with the daily job vacancy stock. The daily flow of new vacancies averages in the quarter 0.02% of employment,²² considerably lower than the average daily vacancy stock (around 1.3%). Both the daily flow of new vacancies and the job-filling rate strongly differ depending on the day of the quarter, ranging from 0 to, respectively, 0.36% and 24%. Peaks of both the two daily series are generally observed at the beginning of each month, during the middle of the month and between its end and the beginning of the next one. They correspond, respectively, to peaks and troughs of the job vacancy daily stock series (see also Figure 2). Although the job vacancy stock also considerably varies within the quarter, it does not show the same strong variations as the daily flow of new vacancies and the job-filling rate, due to the general low levels of these last two daily series. In fact, neither does the former significantly raise the stock of vacancies nor does the latter markedly lower it until fully depleting it.

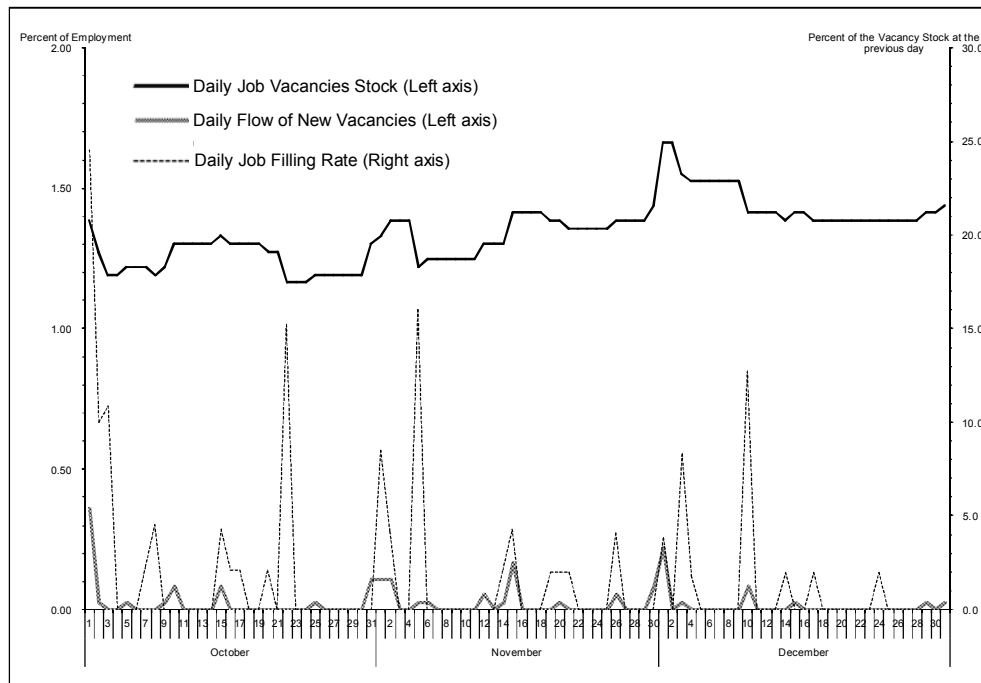
Table 7 - Enlarged Set of Measures of Friction (a)

Quarterly Framework (4th Quarter 2007)	
Job Vacancy Rate	1.42
Vacancy Yield	1.43
Estimated Average Duration of Recruitment (<i>days</i>)	64.17
Proportion of Non-Instantaneous Hirings (<i>% of total hirings</i>)	83.12
Adjusted Vacancy Yield	1.31
Adjusted Estimated Average Duration of Recruitment (<i>days</i>)	70.05
Daily Framework (average daily values in the quarter)	
Vacancy Stock (<i>% of employment</i>)	1.34
Job-Filling Rate (<i>% of the vacancy stock at the previous day</i>)	1.70
Flow of New Vacancies (<i>% of employment</i>)	0.02
Duration (<i>days</i>)	76.47
Duration including also "Vacancy with Negligible Duration" (<i>days</i>)	75.18

Source: Experimental survey on job vacancy flows and duration.

(a) Job vacancy rate, vacancy yield and duration of recruitment are as defined in the text.

²² Multiplying the average daily flow rate by the number of days of the quarter the resulting quarterly flow of new vacancies rate is lower than that shown in Table 6 (1.85% with respect to 1.94%), since the first does not include the inflow of new vacancies cancelled during the quarter. These vacancies have been estimated at a quarterly level (as described in section 5.4) but not at a daily level, with their opening and closing dates not being available.

Figure 3 - Daily Job-Filling Rate, Flow of New Vacancies and Vacancy Stock

Source: Experimental survey on job vacancy flows and duration.

7. Concluding Remarks

This paper examines some basic facts on job vacancies and their connection to hirings, not yet directly observed in the current job vacancy surveys. Also some important issues in the measurement of job vacancy variable are analysed. The data of a recent experimental survey on job vacancy flows and duration have been used, a small purposive non-random sample of Italian employers. This survey is aimed at both assessing whether any employers are able to provide data on the above facts and at preliminarily measuring them.

We find initial evidence that around 1 in 6 hirings occurs without benefit of a prior vacancy. The evidence collected in the experimental survey also shows several ways in which hirings can occur without a reported vacancy as when employers create new job positions to hire attractive candidates recommended by the employees already working in the firm, or when employers hire someone they have previously engaged as a temporary worker or intern, or when employers hire someone previously engaged by an external supplying firm. Besides hirings not preceded by any active recruiting activity like those specified above, hirings preceded by a recruitment process which is so short that the distinction between recruiting and hiring is negligible also appear. For example, when new employees are recruited from an already established pool of former workers which employers usually turn to without any additional recruitment efforts.

We also start to show that vacancies withdrawn from the market without being filled account for more than 10% of all the vacancies closed, whether filled or cancelled. Our findings also suggest that employers cancel job vacancies not only when vacancies are hard-to-fill, but also when they overestimate the need for new workers or when job vacancies are filled by means of a reorganization using internal employees.

We develop an enlarged set of measures of friction in terms of deviations from instantaneous hirings, including not only the job vacancy rate and the estimated average recruitment time, but also the proportion of non-instantaneous hirings – as complementing the hirings without vacancies – and the job vacancy duration. We find preliminary evidence of vacancies which take quite a long time to be filled with an average duration of two and a half months.

Even if a non-representative sample is used in the experimental survey, the results obtained begin uncovering some parts of the still unknown recruitment statistics. They can be regarded as a first step for future, more extended, surveys which could provide useful input for further developments of search and matching models. We find initial evidence – in particular the fraction of hirings that are outside the standard matching framework and of cancelled vacancies – indicating that more information is needed to throw light upon these important aspects of friction in job matching. Furthermore, the fact that we are able to receive from some employers data on the connection between vacancies and hirings as those required in the experimental survey encourages us to continue collecting this information in more extended surveys. It will also allow more detailed analysis, including, for instance, the territorial and sectorial ones.

The empirical analysis we carry out provides us with some useful initial input for improving the measurement of the job vacancy variable. We find that total inflows and outflows of vacancies during the reference quarter significantly exceed the stock at its end by more than 30%. In addition to this, we show that around 2 out of 5 of all the new vacancies opened in the reference quarter are unmeasured by the stock at the end of the quarter, with these new vacancies closed before this date. We also find that the vacancy stocks at each day of the reference quarter significantly differ and that the stock observed at the end of the quarter is 7% higher than the average daily stock in the quarter. These findings suggest complementing the information on the point-in-time vacancy stocks – the measure of vacancies mainly used in the current job vacancy surveys – with that on vacancy flows in order to get more representative information.

The initial evidence obtained from the experimental survey also warrants completing the information on job openings, or recruitment processes, with that on unfilled jobs, which are a more accurate measure of the unmet labour demand. Our results show that more than 1 out of 2 of all the job vacancies collected are unoccupied job openings which are immediately available.

Furthermore, the evidence collected suggests that at least some employers could rely heavily also on recruiting practices that are difficult to be captured by current measurements of job vacancies, but which should be included by them to contain the possible underreporting of vacancies by the employers responding to the job vacancy surveys.

Finally, we also find evidence that at least some employers formally record a lot of useful and highly detailed information on job vacancy characteristics, including the job vacancy opening and closing dates. In the long run, this valuable information could be exploited by the already existing or possible future job vacancy surveys.

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Estimation of Structural Business Statistics for Small Firms by Using Administrative Data

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The need of handling missing response and potential bias in the estimation of business statistics has brought to exploit new possibilities offered by administrative sources in the estimation of Structural Business Statistics (SBS) for small-medium enterprises. The joint use of fiscal agency sources and balance sheet data with survey data, has led to a more integrated approach in the production process. The purpose of this work is to describe the new integrated approach and of measuring the reduction of the sampling error with the new estimation process by distinguishing a source effect from the non response effect. The paper is articulated in the following steps: (i) analysis of the coverage of the survey units through administrative sources by stratification variables, such as the economic activity, the number of persons employed and the legal form; (ii) comparison of meaning and content of the variables from balance sheets and tax data with the corresponding SBS variables; (iii) imputation of unit non-response through administrative data and re-weighting of the final sample to obtain a new estimate for 2007; (iv) evaluation of the discrepancy between the old and the new estimates and evaluation of the non response effect.

Keywords: Unit non-response, Micro integration, Administrative sources, Calibration estimators, Sampling error.

Introduction¹

Within a general plan moving towards a modernization of the production of structural business statistics at a European level, many National Statistical Institutes have indicated a willingness to increase the use of all available administrative sources, which have relevant economic information, in the statistical production process in order to reduce statistical burden on enterprises and to enhance the statistical quality of surveys in terms of comparability with other sources and reduction of missing response bias (Yung, 2008), (Eurostat, 1999).

To this end a review of the availability and of the quality of administrative sources has been carried out at Istat in order to use this information from a new point of view. Administrative data should be used not only for imputing item non-response and unit non-response, but also for sampling designs and for an integrated survey system, in order to obtain coherent estimates. The Statistical Business Register (BR) is obviously correlated to this process by means of its role of both list frame for surveys and as a record linkage basis.

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This paper illustrates the statistical production process for Small and Medium-sized Enterprise sample survey (SME) until the reference year of 2007, in which balance sheets are only used for imputing non-response. Afterwards it shows the new integration process (tested on 2007 and adopted from 2008 onward) in which all administrative sources are combined with survey information. Finally it investigates, for 2007 data, the differences in estimation outcomes by distinguishing the sources of discrepancies.

1. The Small-Medium Enterprises Survey

Small and Medium-sized Enterprises (SME) sample survey is carried out annually by sending a postal questionnaire with the purpose of investigating profit-and-loss account of enterprises with less than 100 persons employed, as requested by SBS EU Council Regulation n. 58/97 (Eurostat, 2003) and n. 295/2008. The units involved in the survey have also the possibility to fill in an electronic questionnaire and transmit it to Istat via web.

The survey covers enterprises belonging to the following economic activities according to the Nace Rev.1.1 classification:

- Sections C, D, E, F, G, H, I, J (division 67), K;
- Sections M, N and O for the enterprises operating in the private sector.

Main variables of interest asked to the SME sampled enterprises are Turnover, Purchases of goods and services, Personnel costs, Wages and salaries, Investments, Employments and other variables useful for calculating Value added at factor cost and Production value. They are also asked to specify their economic activity sector and geographical location in order to test the correctness of the frame with respect to these information. Totals of variables of interest are estimated with reference to three typology of domains of study.

1.1 Frame of interest

The frame for SME survey is represented by the Italian Statistical Business Register (BR). It results from the logical and physical combination of data from both statistical sources (surveys) and administrative sources (Tax Register, Register of Enterprises and Local Units, Social Security Register, Work Accident Insurance Register, Register of the Electric Power Board) treated with statistical methodologies. Variables in the register are both quantitative (Average number of persons employed in the year $t-1$, Number of persons employed in date 31/12/year $t-1$, Number of unpaid persons employed in date 31/12/year $t-1$, Number of enterprises) and qualitative (Geographical location, Economic activity according to Nace Rev.1.1- 4 digit). From the Fiscal Register is also provided the VAT Turnover, which represents a good proxy of the variable Turnover asked to the sampled enterprises by questionnaire.

The population of interest for SME sample surveys is about 4.5 millions active enterprises for the reference year 2007.

The survey is launched in June of the year $t+1$ on the basis of the year $t-1$ BR year t being the reference year of the survey. The updated frame is available for the estimation phase only 15 months after the end of year t . New enterprises (births) are not included in the BR with which the survey has been launched (year $t-1$), while they are surely present in the updated

BR of the year t . Errors in coverage of the BR with respect to new businesses may lead to estimates bias. Also errors due to BR time lag have an impact on SME final estimates.

1.2 Sampling design (allocation and domain of estimates)

SME is a multi-purpose and multi-domain survey and it produces statistics on several variables (mainly economic and employment variables) for three types of domains, each defining a partition of the population of interest (see Tables 1 and 2) (Falorsi et al., 1998 Istat, 2009).

Table 1 - Types of SME Survey domains

Type of domain		Number of Domains
Code	Description	
DOM1	Class of economic activity (4-digit Nace Rev.1) (a)	461
DOM2	Group of economic activity (3-digit Nace Rev.1) by size-class of employment	1.047
DOM3	Division of economic activity (2-digit Nace Rev.1) by region	984

Source: Survey of Small-Medium Enterprises

(a) Nace Rev.1 = Statistical Classification of Economic Activities in the European Communities.

Table 2 - Definition of Size-classes of employment for domain DOM3 of SME Survey

Nace Rev.1.1 2-digit level	Size-classes (Number of persons employed)
10-45;	1-9; 10-19; 20-49; 50-99;
50-52;	1; 2-9; 10-19; 20-49; 50-99;
55;60-64;67;70-74;	1; 2-9; 10-19; 20-49; 50-99;
80; 85; 90; 92; 93;	1-9; 10-19; 20-49; 50-99;

Source: Survey of Small-Medium Enterprises

Sampling design of the SME survey is a one stage stratified random sampling, with the strata defined by the combination of the modality of the characters Nace Rev.1.1 economic activity, size class and administrative region. A fixed number of enterprises is selected in each stratum without replacement and with equal probabilities. The number of units to be selected in each stratum is defined as a solution of a linear integer problem (Bethel, 1989).

In particular, the minimum sample size is determined in order to ensure that the variance of sampling estimates of the variable of interest in each domain does not exceed a given threshold, in terms of coefficient of variation. In this way, about 103,000 of small and medium-sized enterprises (units) are included in the sample. The sampling units are drawn by applying JALES procedure (Ohlsson, 1995), in order to take under control the *total statistical burden*, by achieving a negative coordination among samples drawn from the same selection register.

1.3 The unit non-response

In SME survey of the reference year 2007 about 37,000 questionnaires were filled in by enterprises. The response rate is approximately 42% in terms of reliable replies (excluding non contacted units, out of coverage and list errors).

Actions to speed up or increase the response rate have been adopted: enterprises on delay are subjected to one reminder by post and one by phone.

The survey data have been integrated with administrative ones in the 20-99 size class for about 6,300 units, by using balance sheets. In this way the estimates have been calculated on the basis of 43.701 units (response rate of roughly 47%).

Data imputation for unit non responses is done as follows:

1. selecting randomly a donor enterprise with the same principal activity (Nace Rev.1.1 4-digit), size class and geographical area as the non-respondent unit to be imputed;
2. calculating the donor per-head values;
3. multiplying the values obtained by the number of persons employed (as resulting from the updated frame) of the missing enterprise;
4. After the step number 3 the unit non-response dataset is linked with administrative source (balance sheet database) and the missing value (estimated by donor methods) is replaced with balance sheet value if available.

An enterprise can be used as a donor for not more than 5 times; if there is not any available donor, the constraints on geographic location and Nace Rev.1.1 may eventually be relaxed (Nace Rev.1.1 from 4 to 3 digit).

Table 3 - Sample units,* respondents and unit non-response rate by sector of activity and size class

	Sample units (n)	Respondents (m)	Unit non-response rate %
Economic activity			
Mining	927	425	54.2
Manufacturing	35372	16845	52.4
Energy	1013	540	46.7
Construction	4447	2066	53.5
Trade	16995	8400	50.6
Hotel, Restaurant	2586	1066	58.8
Transport	6107	2530	58.6
Financial services	1328	598	55.0
Business services	14967	7202	51.9
Social services	9079	4029	55.6
Size class (Number of persons employed)			
1-9	61480	24570	60.0
10-19	14541	6237	57.1
20-49	11720	8829	24.7
50-99	5080	4065	20.0
Total	92821	43701	52.9

Source: Survey of Small-Medium Enterprises

(*) Net of inactive units and list errors.

Table 3 shows the unit non-response rates by activity sector and by size class, that is equal to the difference between the sample units (n) and respondents (m) divided by the sample units (n). The missing response seems to be correlated to the enterprise size class and it is more concentrated in sectors such as Transport, Hotel and Restaurant and other service activities. So the use of traditional estimator could generate biases.

1.4 The weighting procedure

Correction factors for theoretical sampling weights for unit non-response and under-coverage are calculated in the estimation phase by applying the methodology based on calibration estimators (Deville and Särndal, 1992).

The estimator of the total $Y(D)$ referred to the domain D is:

$$\tilde{Y}_{(D)} = \sum_{k \in s_r} w_k y_k I_k(D)$$

where s_r is the set of respondent units (respondent and imputed); k is the unit index, w_k is the final weight, y_k is the observed (or imputed) value of the variables of interest; $I_k(D)$ equals 1 if the unit k belongs to domain D , and 0 otherwise

The final weight w_k is obtained as a product of three factors:

$$w_k = d_k \gamma_{1,k} \gamma_{2,k}$$

where

- d_k is the direct weight (the reciprocal of the inclusion probability);
- $\gamma_{1,k}$ is the total non-response correcting factor;
- $\gamma_{2,k}$ is the “post-stratification” factor.

After calculating the total non response correcting factors as the ratio of the number of sampled units and the number of respondent units belonging to appropriate “weighting adjustment cells”, the weight of every single enterprise is further modified in order to match known or alternatively estimated population totals called benchmarks. In particular, known totals of selected auxiliary variables on BR (Average number of persons employed in the year t-1, Number of enterprises) are currently used to correct for sample survey non-response or for coverage error resulting from frame undercoverage or unit duplication (Casciano et al., 2006).

2. The matching between SME survey sample and administrative sources

2.1 The administrative sources used in the process

The sources used in this experimental analysis are the balance sheets and the tax revenue sources (Sector Studies and Tax returns) all linked with the BR identifying code (Bernardi et al., 2010). The whole population of the BR is about 4.5 million of enterprises which employ approximately 17.6 million average annual workers. Only a part of it, the companies, is liable to fill in the balance sheet: they are less than 20%, although they represent about 57% of persons employed. This source is the best one harmonized with the SBS Regulation definitions. All other enterprises are obliged to declare their taxable income to the Fiscal Authority by filling in tax forms. Based on their legal form and of the accountancy regime, enterprises have to fill in different types of tax forms. According to the simplified accountancy regime, sole proprietorships (PF) have to fill in the PF-RE, if

they are freelances, or the PF-RG form, if they are firms in a simplified accounting regime; the unincorporated firms (SP) must fill in the SP-RG form, and the corporate ones (SC) have to compile the SC-RS.

Besides tax return and balance sheet sources, Istat also acquires, directly from the Tax Authority, the Sector Studies (Fiscal Authority Survey): it is a fiscal survey aiming to evaluate the capacity of enterprises to produce income and to know whether they pay taxes correctly. In spite of some exclusion and non-enforceability principles, almost all enterprises are obliged to fill in the Sector Studies survey questionnaire together with the tax return one and to declare in detail costs and income items. As the common part of all sector studies questionnaires is like a balance sheet, it can be used in a more effective way than tax return data.

Since different types of data sources have been used for recovering information about non-respondents units of the initial sample, it has been necessary to determine priorities in using only one of them in the imputation process. For that, it has been defined a ranking priority among the different sources, shown in Table 4, based on the number of available comparable variables and on the coherence to the SME survey variables in terms of number of effective Kolmogorov-Smirnov tests (KS), that have been made on the distribution of similar variables across different sources.

Table 4 - Comparable variables and Kolmogorov-Smirnov test by sources

ADMINISTRATIVE SOURCE	Comparable variables	Test KS (variables with similar distributions)
Balance sheets	21	13
Sector Studies	15	8
Tax Return - PF-RE	13	6
Tax Return - PF-RG	14	6
Tax Return - SP-RG	14	6
Tax Return - SC-RS	16	2

Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

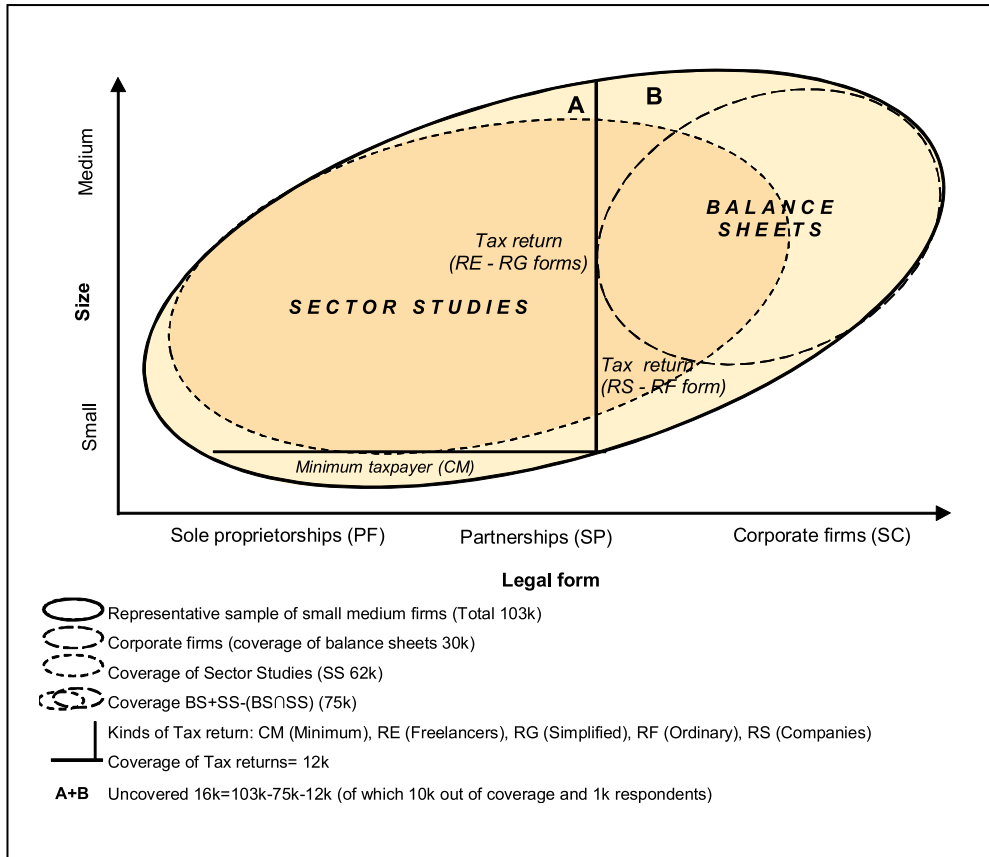
High priority is given to balance sheets. Indeed, among 21 comparable variables, that refer to the same definition of SBS, 13 of them have a similar distribution. Then the Sector Studies survey (15 comparable variables, 8 of them with a similar distribution) and last the tax return source: 6 coherent variables for PF kinds and 2 coherent variables for SC kinds.

2.2 The coverage of available Administrative sources

After the coherence analysis among subsidiary sources (Table 4), it has been done an analysis of the coverage of the sample of the SME survey of 2007 in terms of number of units and of their information contents. Unless coverage list errors, balance sheets and Sectors studies together with Tax returns, cover almost all sampled enterprises. The coverage (Figure 1) of balance sheet units amounts to about 30 thousands units on a theoretical sample of 103 thousand. The additional coverage from Sector studies adds up roughly to 45 thousand and the supplementary coverage of tax returns data amounts to 12 thousand units. The residual, not covered, sample units (16 thousand) represent some large and very small sole proprietorships. The large ones (with an ordinary accountant regime)

are obliged to fill the RF form of Tax return module which is not comparable with the profit & loss scheme. The very small ones, called minimum taxpayer, only from 2008 are liable to compile a special tax return form named CM.

Figure 1 - Coverage analysis by legal form and size class of the enterprise - Year 2007



Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

Table 5 shows the sample coverage figures according to the administrative source used and following the priority rule defined before.

Table 5 - Coverage of the theoretical sample by kind of response and administrative source - Year 2007

ADMINISTRATIVE SOURCE	Sample of respondents	Unit non-response	Total sample
Balance sheets	19,739	10,370	30,109
Sector Studies (F)	17,798	24,655	42,453
Sector Studies (G)	1,223	1,343	2,566
Tax Return - PF-RG	990	2,312	3,302
Tax Return - PF-RE	483	747	1,230
Tax Return - SP-RG	378	810	1,188
Tax Return - SC-RS	1,839	4,546	6,385
From survey only	1,251	0	1,251
Total	43,701	44,783	88,484
No sources			4,337
Out of coverage and list errors			10,218
Total sample units			103,039

Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

Unless of list errors the total coverage is about 95%, half from the sample of respondents and half from administrative sources.

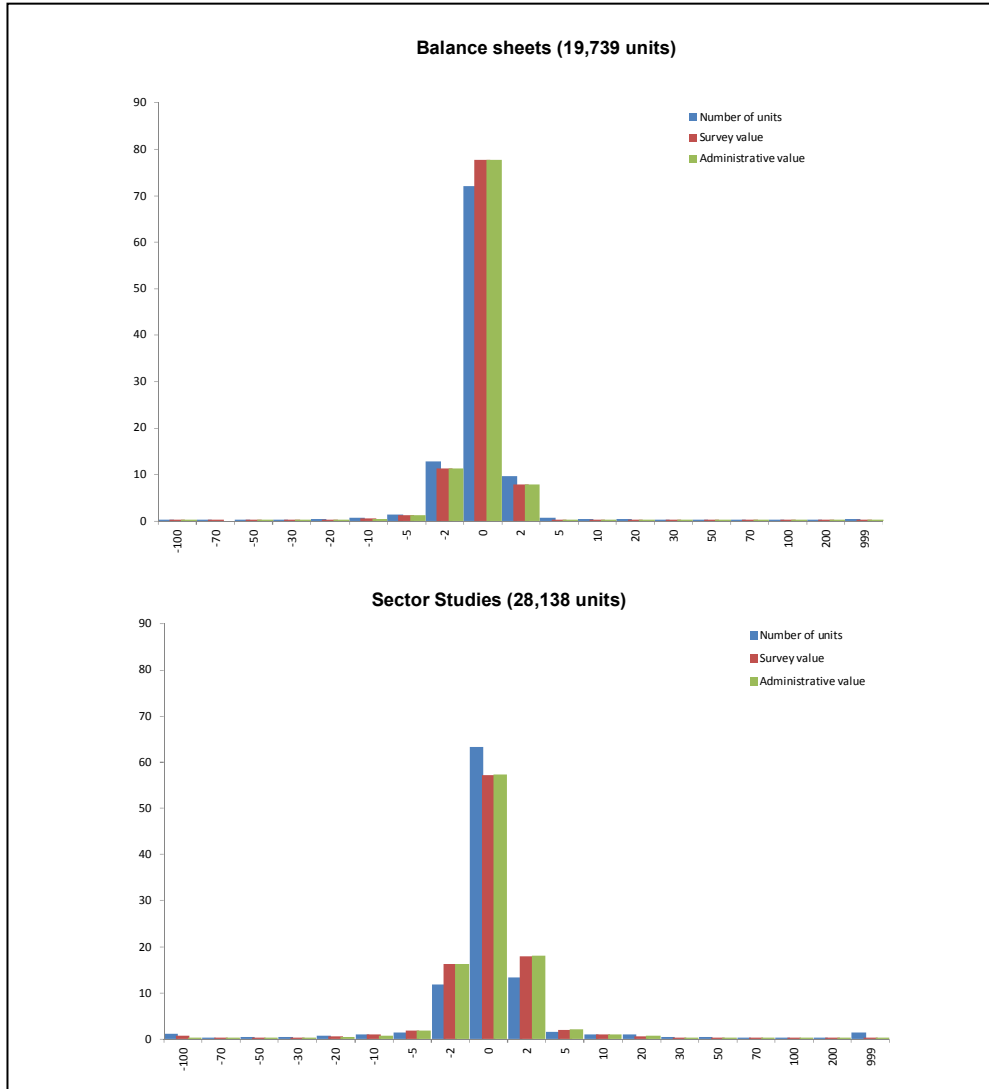
Despite of the very high level of coverage, several issues still remain about the total number of variables to be used and the harmonization of definitions among sources.

2.3 The information contents and harmonization among sources

The variables common to all sources (Balance sheets, Sector Studies survey, Tax Return data) are the following: Income from sales and Services (Turnover), Changes in stock, Changes in contract work in progress, Other income and earnings (neither financial, nor extraordinary), Purchases, Purchases of goods and services, Services (Total), Use of third party assets, Value adjustments, Fund allocations, Other operating charges, Personnel costs. Moreover there are two further variables, Value added and Gross operating value that can be calculated with the previous ones.

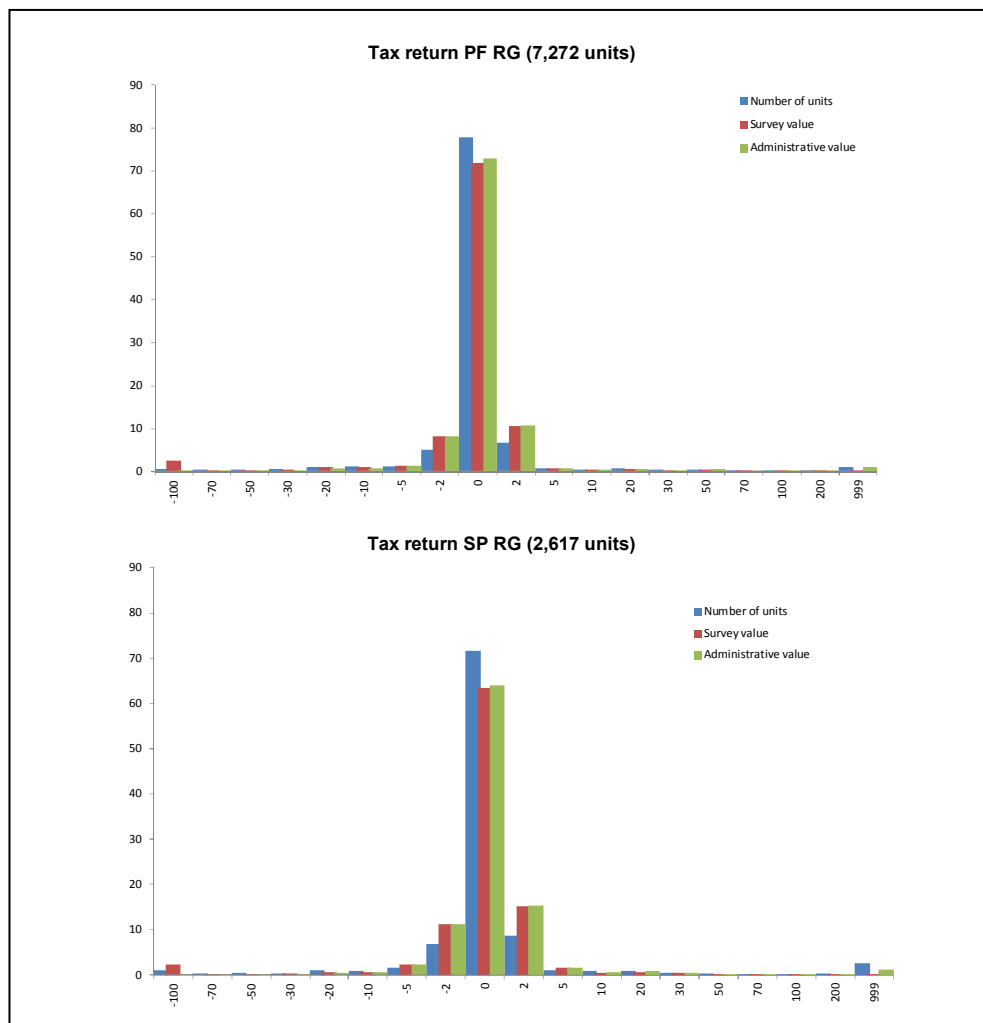
The variables content comparability has been assessed by comparing both their definitions and values in frequency distribution with survey variables (Oropallo and Inglese, 2004). For instance, once assessed the contents are defined in a similar way, the distribution by classes of differences between sample survey variables and source variables (Balance sheets, Sector Studies survey, Tax Return PF and Tax Return SP) can be drawn, as it is showed in Figure 2 for Turnover.

Figure 2 - Turnover, distribution of respondent units linked with administrative sources by classes of differences - Year 2007 (percentage values)



Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

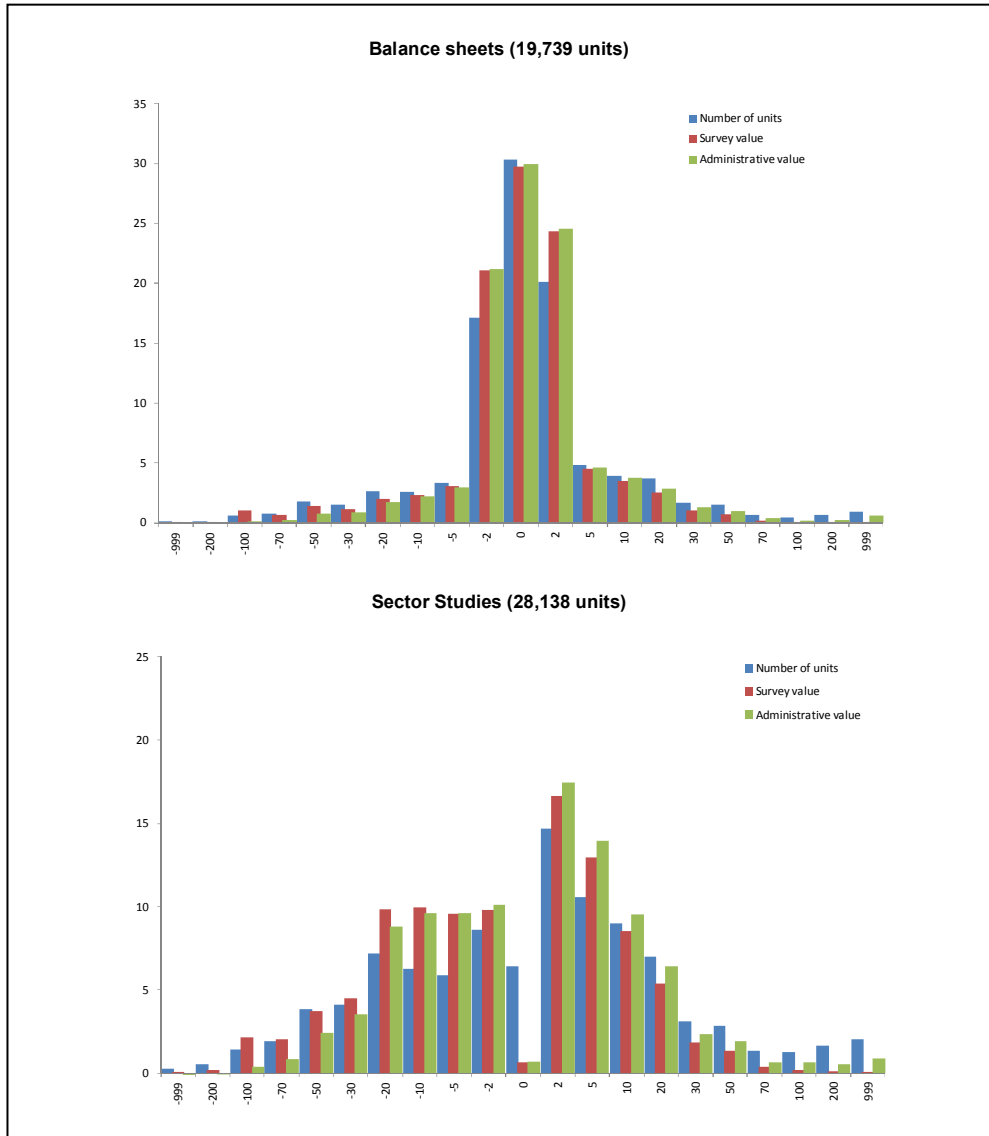
Figure 2 segue - Turnover, distribution of respondent units linked with administrative sources by classes of differences - Year 2007 (percentage values)



Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

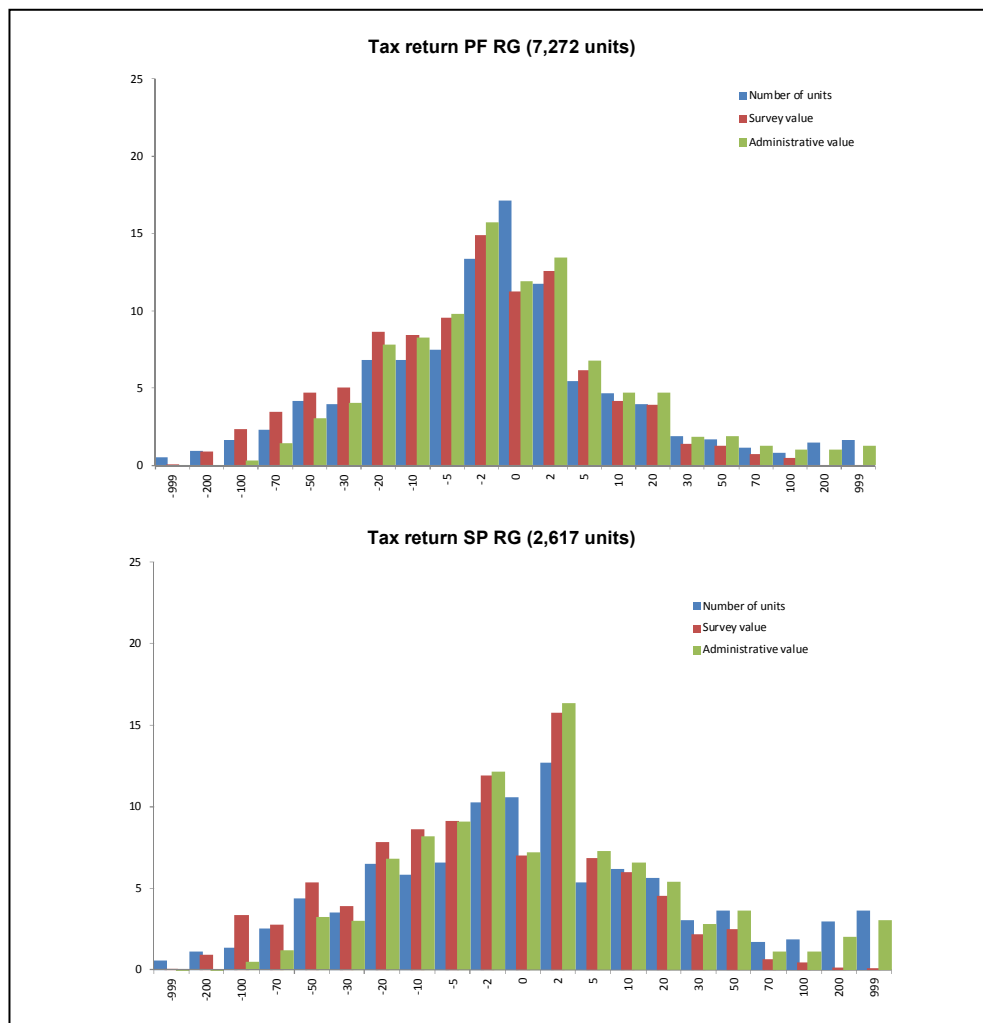
About 94% of total observations, linked with the balance sheets (19,739 units), show differences in the value of turnover lower than 2% and 70% with identical values. For the fiscal sources the analysis is satisfying too. For the first one (Sector Studies) a percentage of 88% of observations lies between the range of $\pm 2\%$, with a 63% with identical values. For the other sources (Tax return modules RG (simplified accounting scheme) for sole proprietorships (PF) and partnerships (SP)) concordance of turnover value, between $\pm 2\%$, is above the 80%. For all cases it is observed a symmetric distribution of differences, that give an evidence of the randomness of errors and the normality test on the distribution of the differences is statistically significant (the Kolmogorov-Smirnov is good and the statistic is equal to 0.4 with a p-value lower than 1%).

Figure 3 - Value added, distribution of respondent units linked with administrative sources by classes of differences - Year 2007 (percentage values)



Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

Figure 3 segue - Value added, distribution of respondent units linked with administrative sources by classes of differences - Year 2007 (percentage values)



Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

The reconstruction for each observation of the variable Value added through the administrative data has been more complex because it is a result of an algebraic sum of more budget items. In the balance sheets case the situation is better than the fiscal sources. In this latter cases there have been encountered difficulties in the perfect reconstruction of cost items that are affected by the fiscal legislation. Nevertheless for the Sector Studies at least 46% of linked observations and 55% of the Value Added lie between an error of +/- 5% and at least 60% of linked observations and 72% of the Value added lies between an error of +/- 10%. Also in this case the normality test on the distribution of the differences is statistically significant for balance sheets (the statistic Kolmogorov-Smirnov is equal to 0.4 with a p-value lower than 1%).

Finally the comparative analysis shows in each case zero-balanced and symmetric distribution of differences that can be assimilated to a random error.

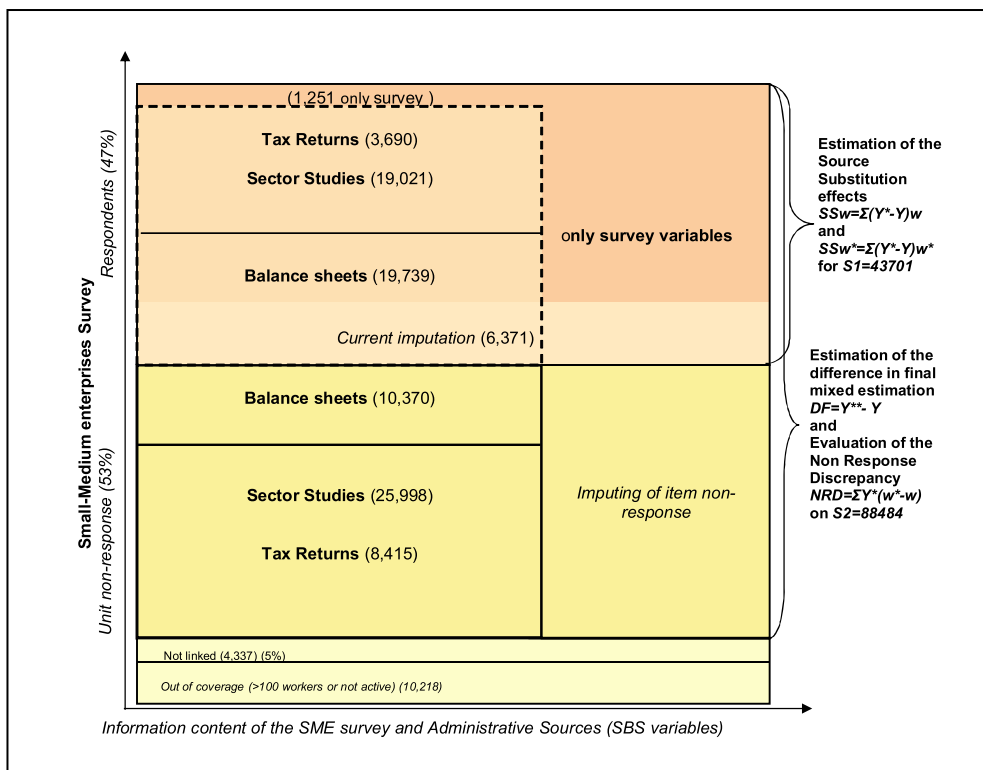
3. Integration of SME survey with administrative sources and re-estimation

3.1 Imputation of unit non-response with data from administrative sources

Administrative sources permit to cover almost all sample units of the SME survey, so it has been possible to extend the reconstruction of SBS variables both for respondent units or non respondent ones.

On the y-axis (Figure 4) the theoretical sample is broken down between respondents (47%) and unit non response (53%). The x-axis represents the dimension of the information content. Administrative sources (Balance sheets and Tax data) cover only a part of the information contained in the survey questionnaire. For the covered part it is possible to compare survey variables (Y) with SBS variables calculated with balance sheets, sector studies and tax returns (Y^*).

Figure 4 - Integration frame of the SME Survey with Administrative sources - Year 2007



Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

The initial estimate, based on the subset of respondents ($S1$) is:

$$\tilde{Y}_\alpha = \sum_{S1} y_k w_k$$

Estimate based on administrative sources ($S2$), with a new set of final weights, is:

$$\tilde{Y}_\alpha^* = \sum_{S2} y_k^* w_k^*$$

Final estimate on the integrated sample ($S2$) is:

$$\tilde{Y}_\alpha^{**} = \sum_{S1} y_k w_k^* + \sum_{S2-S1} y_k^* w_k^*$$

that can be written as:

$$\tilde{Y}_\alpha^{**} = \sum_{S2} y_k^* w_k^* + \sum_{S1} y_k w_k^* - \sum_{S1} y_k^* w_k^* = \tilde{Y}_\alpha^* - \sum_{S1} (y_k^* - y_k) w_k^*$$

In this way the integrated estimate (survey plus administrative) is equal to the estimate based on administrative sources with new weights minus the weighted discrepancy between sources.

3.2 Calculation of the estimation discrepancy

Starting from the previous formulas, various component of the final estimation difference can be highlighted.

The difference between the administrative (Y^*) and survey (Y) estimate is equal to:

$$\tilde{Y}_\alpha^* - \tilde{Y}_\alpha = \sum_{S2} y_k^* w_k^* - \sum_{S1} y_k w_k$$

where \tilde{Y}_α^* is the new variable calculated with the administrative source and w_k^* the new vector of final weights is obtained after the new calibration procedure:

$$w_k^* = d_k \gamma_{1,k}^* \gamma_{2,k}^*$$

This new version of final weights fundamentally reduce the role of the adjustment for total non response: $\gamma_1^* < \gamma_1$. On the overall initial sample of roughly 93 thousands units, the new respondents are roughly 88.5 thousand units, with an average correction factor $\gamma_1^* = 1.05$. Instead of the correction factor described in par. 1.4 $\gamma_1 = 2.12$.

Adding $\sum_{S1} y_k^* w_k^*$ and subtracting $\sum_{S2} y_k^* w_k^*$ in the difference formula, where w_k is zero for all units of $S2$ not included in $S1$, the result is the following:

$$\tilde{Y}_\alpha^* - \tilde{Y}_\alpha = \sum_{S2} y_k^* w_k^* - \sum_{S1} y_k w_k + \sum_{S1} y_k^* w_k^* - \sum_{S2} y_k^* w_k^*$$

That can be grouped in the following two components:

$$\tilde{Y}_\alpha^* - \tilde{Y}_\alpha = \sum_{S1} (y_k^* - y_k) w_k + \sum_{S2} y_k^* (w_k^* - w_k)$$

Moreover considering the integrated estimate \tilde{Y}_α^{**} , as the final new estimate, it is possible to calculate the total difference. So, considering that:

$$\tilde{Y}_\alpha^{**} = \tilde{Y}_\alpha^* - \sum_{S1} (y_k^* - y_k) w_k^*$$

and introducing the component “source substitution effect” evaluated with the new weights $\sum_{S1} (y_k^* - y_k) w_k^*$ in the final difference:

$$DIFF = \tilde{Y}_\alpha^{**} - \tilde{Y}_\alpha = \tilde{Y}_\alpha^* - \tilde{Y}_\alpha - \sum_{S1} (y_k^* - y_k) w_k^*$$

the previous difference (DIFF) becomes:

$$DIFF = \tilde{Y}_\alpha^{**} - \tilde{Y}_\alpha = \sum_{S1} (y_k^* - y_k) w_k - \sum_{S1} (y_k^* - y_k) w_k^* + \sum_{S2} y_k^* (w_k^* - w_k)$$

$$DIFF = SSW - SSW^* + NRD$$

in which the total difference can be decomposed into three effects:

- The source substitution for S1 with old weights: $SSW = \sum_{S1} (y_k^* - y_k) w_k$;
- The source substitution for S1 with new weights: $SSW^* = \sum_{S1} (y_k^* - y_k) w_k^*$;
- The unit non-response discrepancy for S2: $NRD = \sum_{S2} y_k^* (w_k^* - w_k)$.

3.3 Measurement of coherence among different sources and evaluation of the missing response effect

The analysis of differences in the final estimate have been evaluated for the following economic variables: Turnover and Value Added.

Table 6 shows the decomposition of differences between the official estimate of Turnover Y and the new estimate of Turnover Y^{**} obtained combining survey and administrative sources.

The new estimate is very close to the initial one with a percentage difference of +0,03%, although there is a high variability in results when we breakdown economic activities and size classes. The source substitution effect is equal to -1.07 (old weights) and -0.66% (new weights) compared to the previous estimate and it is greater for small firms (10-19 and 20-49 workers). In particular for industry with 10-19 workers and construction and service activities with 20-49 workers. The difference due to the unit non-response is higher in construction activities and lower in service sector. For that non response has produced a higher estimate of turnover for micro and small firms (new weights decrease of 0.5% the previous estimates) and a strong under estimate for medium enterprises (3.33%) especially of service sectors.

Table 6 - Turnover estimates, analysis of the differences between sources and evaluation of the unit non-response effect by sectors of activity and size class - Year 2007 (percentage difference)%DIFF - Total difference in final estimates $(Y^{**}-Y)/Y\%$

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	4.33	-0.89	-0.66	3.13	1.36
Constructions	-6.92	-7.86	16.01	-3.48	-3.53
Services	-0.81	-0.04	0.31	3.99	0.06
Total	-0.96	-1.25	1.15	3.21	0.03

SSw - Source substitution effect for S1 (with old weights)

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	-0.23	-3.30	-0.82	-0.54	-1.16
Constructions	-0.67	-0.09	-2.62	0.60	-0.76
Services	-0.64	-1.21	-2.71	-0.70	-1.09
Total	-0.59	-1.77	-1.89	-0.56	-1.07

SSw* - Source substitution effect for S1 (with new weights)

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	-0.43	-1.41	-0.74	-0.40	-0.73
Construction	-0.46	-0.23	-3.29	0.67	-0.82
Services	-0.03	-0.93	-2.15	-0.59	-0.60
Total	-0.15	-1.02	-1.65	-0.44	-0.66

NRD - Difference due to unit non-response

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	4.13	1.00	-0.58	3.27	1.80
Constructions	-6.71	-8.00	15.34	-3.40	-3.59
Services	-0.20	0.25	0.87	4.10	0.55
Total	-0.53	-0.50	1.39	3.33	0.44

Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

Table 7 shows the decomposition of differences between the old estimate Y of Value Added and the new estimate Y^{**} of Value Added obtained combining survey and administrative.

Table 7 - Value Added estimates, analysis of the differences between sources and evaluation of the unit non-response effect by sectors of activity and size class - Year 2007 (percentage difference)%DIFF - Total difference in final estimates $(Y^{**}-Y)/Y\%$

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	-3.24	-3.16	-2.37	1.90	-1.88
Constructions	-8.16	-8.93	2.19	-1.51	-6.35
Services	-5.99	-5.62	-2.79	-3.91	-5.32
Total	-5.95	-5.25	-2.03	-0.84	-4.50

SSw - Source substitution effect for S1 (with old weights)

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	-1.22	-3.30	-0.41	-0.58	-1.33
Constructions	0.21	6.51	-2.49	-9.12	0.51
Services	1.53	-0.86	-5.00	1.13	0.26
Total	0.94	-0.57	-2.62	-0.51	-0.15

SSw* - Source substitution effect for S1 (with new weights)

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	-1.06	-1.76	-0.31	-0.55	-0.89
Construction	0.19	3.08	-2.30	-10.02	-0.38
Services	0.89	-1.20	-3.56	1.14	-0.03
Total	0.50	-0.83	-1.94	-0.57	-0.34

NRD - Difference due to unit non-response

SECTORS	1-9	10-19	20-49	50-99	Total
Industry	-3.08	-1.61	-2.27	1.93	-1.43
Constructions	-8.19	-12.35	2.38	-2.41	-7.24
Services	-6.63	-5.96	-1.35	-3.90	-5.62
Total	-6.39	-5.51	-1.35	-0.90	-4.68

Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

For the Value Added there are higher differences in the size classes 1-9 and 10-19 especially for construction sectors. In any case total difference is more affected by unit non-response than the substitution of data sources (-0.15 and -0.34). The substitution effect is very high in the medium firms of construction (-9 and -10%).

Finally, a simulation study has permitted to evaluate a gain in the efficiency due to the estimator. Performing 1000 jackknife replications for selecting randomly 75% of the sample of respondents with the same stratificated design adopted by the initial sample, the absolute relative bias (ARB) and the relative root mean square error (RMSE) can be expressed in the following way:

$$ARB = \left| \frac{1}{1000} \sum_{r=1}^{1000} \frac{\hat{Y}_r - Y}{Y} \right|$$

$$RRMSE = \frac{1}{Y} \sqrt{\frac{1}{1000} \sum_{r=1}^{1000} (\hat{Y}_r - Y)^2}$$

As for the estimation of Turnover, errors are always lower of more than 1 percentage point. The error has been reduced in the service activities and in the size class 10-19.

Table 8 - Measurement of the efficiency of new estimates of Turnover after 1000 sampling replications - Year 2007 (mean values of strata estimates)

	Y=Turnover (dataset S1)		Y**=Turnover (dataset S2)	
	ARB	RRMSE	ARB	RRMSE
Sector				
Industry	8.22	9.97	7.11	8.62
Constructions	7.06	8.59	5.95	7.35
Services	10.36	12.52	8.97	10.82
Size class				
1-9	7.76	9.40	6.18	7.55
10-19	11.15	13.43	7.83	9.55
20-49	7.40	9.02	7.29	8.92
50-99	10.43	12.65	9.49	11.40
Total	9.18	11.13	7.70	9.35

Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

As for the Value Added, errors are also reduced of roughly 2 percentage point. High gain in efficiency has been verified in all economic activities and for all size classes.

Table 9 - Measurement of the efficiency of new estimates of Value added after 1000 sampling replications - Year 2007 (mean values of strata estimates)

	Y=Value added (dataset S1)		Y**=Value added (dataset S2)	
	ARB	RRMSE	ARB	RRMSE
Sector				
Industry	6.81	8.31	5.76	7.04
Constructions	7.70	9.31	6.62	8.14
Services	9.19	11.24	9.31	11.52
Size class				
1-9	7.18	8.82	6.08	7.59
10-19	9.04	10.99	7.65	9.32
20-49	6.75	8.23	6.01	7.36
50-99	8.49	10.49	8.73	10.94
Total	7.87	9.63	7.12	8.80

Source: Elaborations on data from Administrative Sources and from Survey of Small-Medium Enterprises

Conclusions

The unsatisfactory sampling survey response rate together with the availability of a huge amount of data from administrative sources (balance sheets and tax data) has suggested some adjustments in the SME production process. The integration of the original SME sample with administrative sources has allowed both to increase the response rate from about 47% to roughly 88% and to measure the discrepancies in the final estimation due to unit non-response.

The experimental study shows that the estimates of the previous survey not always are coherent with the new estimates based on the integrated dataset for the presence of a source substitution effect (i.e. discrepancy of the same variable in different sources) and of a missing response effect after the widening of the respondent sample. The discrepancy calculated between the variables of the previous SME survey and the variables of the new integrated dataset is 0.03% for the Turnover and -4.5% for the Value added. Particularly the difference due to unit non-response is higher in some strata (micro-small firms of service and construction sectors) reflecting the fact that the missing response mechanism is not based on a random process. Moreover, the enlargement and the integration of the final dataset, used in the new process of estimation, could reduce the errors of the estimators of roughly 2%.

A further work needs to be done like a more disaggregated analysis (Nace at 4 digits, Nace at 3 digits and size classes) in order to detect errors, to better harmonize tax data for statistical purpose and to reduce the source effects (measurement error). A further analysis on the informative contents of tax data could permit to extend this experiment to other SBS variables. While for other SBS variables which cannot be obtained from administrative sources it will be necessary to develop specific statistical imputation methods. For that aim, it could be desirable that Istat should have an active role in designing tax forms harmonizing concepts and adding some information useful for statistical purposes. Finally it needs to remark that the use of administrative sources for statistical purpose will imply the continuity and the stability over time of the data flow in order to guarantee the requirements of the Eurostat SBS regulation.

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Il principio di conservazione della dinamica e le tecniche di riconciliazione di serie storiche nella stima dell'occupazione trimestrale per settore istituzionale*

Marianna Ascione, Giancarlo Lutero

Sommario

In questo lavoro è esposto il problema della riconciliazione di serie storiche nei conti economici nazionali, in riferimento alle stime trimestrali dell'occupazione per settore istituzionale. Dopo una panoramica sulla struttura dei conti istituzionali trimestrali, sono illustrate le fonti delle discrepanze che si possono originare quando nel processo di stima degli aggregati è necessario rispettare dei vincoli esogeni predeterminati. Una breve introduzione alle tecniche di bilanciamento di dati longitudinali più note è trattata unitamente alla metodologia di Denton, con particolare attenzione alla sua proprietà di conservazione della dinamica (movement preservation principle). Sono infine esaminate le tecniche di riconciliazione di serie storiche con discrepanze temporali e longitudinali, soffermandosi su metodologie a due passi le quali superano alcune difficoltà computazionali. Il lavoro è corredato da un esercizio empirico sulle Unità di lavoro equivalenti a tempo pieno, comparando due diversi approcci di riconciliazione a due passi.

Parole chiave: occupazione trimestrale per settore istituzionale, riconciliazione serie storiche, vincoli temporali e longitudinali, principio di conservazione della dinamica, bilanciamento a due stadi, unità di lavoro equivalenti.

Abstract

In this paper the methods of time series reconciliation in the presence of both contemporaneous and temporal aggregation constraints are discussed, relating to a set of Quarterly Sector Accounts (QSA) estimates. After a brief overview of Quarterly Sector Accounts, the sources of data discrepancies are stressed. A short introduction to the balancing and benchmarking methodologies adopted in operating context are treated. In addition, Denton's methodology is illustrated, remarking the movement preservation principle property. In order to solve computational impasses of a simultaneous solution, a two-steps reconciliation approach is introduced. An empirical exercise on full-time equivalent units is applied to compare several two-steps strategies.

Keywords: quarterly employment by institutional sector, time series reconciliation, temporal and contemporaneous constraints, movement preservation principle, two-steps balancing, full-time equivalent units.

* I risultati di questo lavoro sono stati presentati al workshop su Riconciliazione dei sistemi di serie storiche: sviluppi teorici e applicazioni in Contabilità Nazionale, svoltosi nell'Aula magna dell'ISTAT, il 23 giugno 2009, Roma. Questo contributo è stato realizzato grazie al lavoro congiunto di Marianna Ascione e Giancarlo Lutero. Le sezioni 1, 4, 5 sono state curate da Giancarlo Lutero, le sezioni 2, 3, 6 da Marianna Ascione.

1. Introduzione

In Italia le stime relative ai conti trimestrali nazionali seguono un approccio *top-down*, questo implica che i conti annuali nazionali sono il riferimento vincolante da cui si ricavano, con diverse tecniche ed approcci metodologici, tutte le altre stime prodotte dalla Contabilità Nazionale relativamente ai diversi sottosistemi (oltre ai conti trimestrali, i conti territoriali, i conti istituzionali, i conti ambientali). In altri contesti, la strategia nella produzione degli aggregati di Contabilità Nazionale può procedere in senso inverso, dal particolare al generale (approccio *bottom-up*): si stimano direttamente le variabili a un livello di analisi più dettagliato e, in seguito ad un processo più o meno complesso di aggregazione, si ottenengono le stime dei conti nazionali (pil, consumi, investimenti, risparmio, accumulazione, attività finanziarie, flussi del commercio estero, ecc.). I conti trimestrali per settore istituzionale costituiscono una rappresentazione integrata dei comportamenti dei diversi operatori del circuito economico nazionale, e sono un prototipo di dati soggetti ad una doppia restrizione contabile. Ciascun settore istituzionale è l'insieme delle singole unità istituzionali che possiedono delle caratteristiche economiche e dei comportamenti simili: i settori sono le famiglie, le imprese e la pubblica amministrazione. I conti per settore istituzionale consentono di evidenziare numerosi aggregati che non sono direttamente osservati in altri contesti come ad esempio il reddito disponibile lordo delle famiglie oppure la quota di profitti delle società non finanziarie. La stima degli aggregati annuali è condotta su una base informativa statistica assai diversificata; a livello trimestrale, invece, per integrare l'informazione diretta mancante, oppure troppo onerosa da stimare, si ricorre a dei metodi di calcolo indiretti basati su procedimenti di interpolazione dei dati (tecniche di disaggregazione temporale).¹

Nel processo di stima dei conti nazionali trimestrali, compresi quindi quelli per settore istituzionale, operando a livello di branca di attività economica, si originano delle discrepanze rispetto a delle grandezze esogene che assumono il ruolo di vincoli stringenti; di conseguenza per ogni trimestre è necessario tener conto di tali vincoli operanti come ad esempio le stime annuali per settore istituzionale o i conti trimestrali per il totale economia, ed ancora i conti trimestrali relativi alla pubblica amministrazione. Le restrizioni contabili possono essere di due tipi:

- *vincoli contemporanei*, in cui in ogni istante temporale, una grandezza deve essere la somma o la media di altre grandezze;
- *vincoli di aggregazione² temporale*, dove vi deve essere una consistenza fra una serie storica ad alta frequenza e la medesima formulata a frequenza temporale più bassa (che rappresenta il vincolo).

Tali disuguaglianze possono essere causate da diversi fattori: una differente metodologia di raccolta dei dati, l'uso di diverse tecniche di campionamento, oppure, in mancanza di rilevazione diretta o informazioni supplementari, da una cattiva specificazione delle stime ad un determinato livello di disaggregazione, o da trasformazioni funzionali come la pratica della destagionalizzazione, e in generale l'uso di modelli stocastici o previsivi nell'ambito delle tecniche di disaggregazione temporale.

¹ Per una introduzione si veda Bee Dagum e Cholette (2006).

² Il problema dell'aggregazione non concerne soltanto le serie temporali, ma altresì i dati longitudinali o spaziali, la costruzione degli indici compositi o il *combining forecasting*. È un fenomeno noto sin dagli albori delle scienze statistiche ed economiche applicate, ma è spesso sottovalutato nella pratica. Per una panoramica si veda Lutero (2010).

La necessità di rispettare un principio di coerenza formale fra le grandezze macroeconomiche prodotte nell'alveo dei conti nazionali, come l'eguaglianza fra risorse ed impieghi o la coerenza fra aggregati nazionali e settori istituzionali, conduce necessariamente all'adozione di metodi di bilanciamento dei dati. Con i termini *bilanciamento*, *benchmarking* e *riconciliazione* si indicano nella letteratura, in contesti diversi, le tecniche di ripristino della consistenza formale interna di un insieme di dati ordinati in un array a n dimensioni e, di fatto, i rispettivi totali marginali. Nello specifico per bilanciamento (*balancing*) si intende, in un dato istante temporale, il ripristino della consistenza fra un insieme di dati ed i suoi vincoli contemporanei. Invece le tecniche di *benchmarking* riguardano il ripristino della coerenza temporale fra la media o la somma di serie espresse ad alta frequenza (tipicamente trimestrale) e vincolo temporale a bassa frequenza (dati annuali). Infine i metodi di *riconciliazione* considerano entrambi i tipi di vincoli summenzionati e quindi concernono un sistema di dati più complesso che può causare, superata una certa soglia dimensionale, delle grosse difficoltà operative e computazionali. Le tecniche di riconciliazione a due passi possono ovviare a quest'ultimo inconveniente, semplificando il problema numerico senza alterare o preservando al meglio le caratteristiche dinamiche delle serie.

Lo scritto si articola come segue: la sezione 2 propone una panoramica introduttiva sui conti istituzionali così come si configurano nell'ambito delle stime relative ai conti nazionali; la sezione 3 chiarisce i motivi strutturali da cui si origina il problema della riconciliazione nei conti trimestrali istituzionali; la sezione 4 introduce il bilanciamento dei dati ed illustra sinteticamente alcune delle più note tecniche di riconciliazione di serie storiche, soffermandosi sulle caratteristiche specifiche afferenti la nota procedura di *benchmarking* di Denton; vengono inoltre definiti gli indici di discrepanza adottati per dare una misura del fenomeno della riconciliazione; la sezione 5 presenta un'applicazione, relativa alla stima trimestrale dell'occupazione per settore istituzionale, e commenta i risultati; infine la sezione 6 sintetizza il lavoro e dà indicazioni su possibili sviluppi futuri.

2. I Conti trimestrali per settore istituzionale

I conti nazionali per settore istituzionale costituiscono una rappresentazione integrata dei comportamenti dei diversi operatori economici. Essi illustrano le scelte operate dalle famiglie, dalle imprese e dalle amministrazioni pubbliche nelle fasi essenziali del processo economico: produzione, formazione, distribuzione, redistribuzione e utilizzazione del reddito, accumulazione non finanziaria.

Gli operatori economici sono visti come centri di decisione nel campo economico e finanziario. Essi costituiscono le unità istituzionali che sono raggruppate nei settori sulla base dell'uniformità di comportamento nell'esercizio delle loro funzioni principali. Sulla base delle funzioni prevalentemente svolte e del tipo di risorse utilizzate per il loro finanziamento (ricavi delle vendite, redditi da lavoro o da capitale-impresa, interessi bancari, premi di assicurazione, imposte e contributi sociali, quote associative) le unità sono raggruppate nei seguenti settori istituzionali:

- le *famiglie* che comprendono le famiglie consumatrici, le famiglie produttrici (imprese individuali, società semplici fino a cinque addetti e liberi professionisti) e le istituzioni senza scopo di lucro al servizio delle famiglie;

- le *società non finanziarie* che comprendono tutte le società di persone e di capitale e le imprese individuali con oltre cinque addetti che svolgono la loro attività nei settori diversi da quelli finanziari;
- le *società finanziarie* che includono le Autorità bancarie centrali, le altre istituzioni finanziarie monetarie, gli altri intermediari finanziari, le imprese di assicurazione e fondi pensione e gli ausiliari finanziari;
- le *amministrazioni pubbliche* che producono prevalentemente servizi non destinabili alla vendita (non market), redistribuiscono il reddito e la ricchezza fra gli operatori del sistema, contribuiscono al consumo finale ed al processo di accumulazione. Esse includono le amministrazioni centrali e locali, le amministrazioni di Stati federati ed infine gli enti di previdenza ed assistenza sociale.

A questi settori va aggiunto il settore definito *resto del mondo* che comprende le unità non residenti che effettuano operazioni con le unità istituzionali residenti classificate nei settori sopra elencati.

L'analisi dal punto di vista dei settori costituisce uno strumento utile all'interpretazione della realtà economica del Paese ed è pertanto di fondamentale importanza per l'analisi economica. Nella pratica sono stimati numerosi e differenziati aggregati economici che consentono di calcolare alcuni importanti saldi contabili non direttamente osservabili come il reddito disponibile ed il risparmio. La notevole mole di variabili stimate per settore istituzionale consente la definizione dell'intera sequenza dei conti utile a descrivere i comportamenti degli operatori economici nella formazione del prodotto, nella remunerazione dei fattori produttivi utilizzati, nell'impiego delle risorse da destinare a consumi e investimenti, nella formazione del risparmio e delle attività finanziarie. In generale le procedure di stima adottate definiscono gli aggregati dalla produzione fino al risultato di gestione per branca di attività economica e le operazioni rientranti nei circuiti successivi direttamente a livello di settore.

I dati sono elaborati a cadenza annuale e trimestrale. Soltanto i conti annuali per settore istituzionale sono diffusi nella loro interezza. A livello trimestrale si diffondono alcuni indicatori³ sui risultati ottenuti dai soli settori delle società non finanziarie e delle famiglie. Gli indicatori diffusi sono corretti per la componente stagionale e le serie trimestrali che li definiscono sono diffuse sia grezze che destagionalizzate. A partire dal 2006 in conformità a quanto stabilito nel Regolamento Ue n° 1161/2005, l'intero set di dati trimestrali è trasmesso all'Eurostat a t+90 giorni dal trimestre di riferimento contribuendo alla definizione dei conti economici trimestrali per settore istituzionale dell'Unione Europea (EU27) e dell'Unione Monetaria (EA15), rilasciati a t+120 giorni dal trimestre di riferimento dall'Eurostat e dalla Banca Centrale Europea.⁴

Pur basandosi sui medesimi concetti e definizioni dei corrispondenti conti annuali, i conti trimestrali per settore istituzionale sono stimati ricorrendo a metodi statistici per la limitatezza delle informazioni disponibili a cadenza trimestrale.⁵ La stima degli aggregati

³ Le serie trimestrali relative agli indicatori pubblicati per le società non finanziarie e per le famiglie sono disponibili all'indirizzo: http://www.istat.it/salastampa/comunicati/in_calendario/redisp/20101008_00/

⁴ Le serie trimestrali relative agli indicatori pubblicati dall'Eurostat sono disponibili al seguente indirizzo: http://epp.eurostat.ec.europa.eu/portal/page/portal/sector_accounts/data/quarterly_data/

⁵ Per la metodologia seguita per la stima degli aggregati trimestrali si rimanda all'inventario: http://epp.eurostat.ec.europa.eu/portal/page/portal/sector_accounts/methodology/from_national_to_european_accounts

annuali, infatti, si basa su diverse fonti statistiche che si rendono disponibili generalmente con una frequenza almeno pari all'anno; a livello trimestrale, invece, per integrare l'informazione mancante si ricorre ad appropriate tecniche statistiche definite tecniche di disaggregazione temporale.

Il metodo cui si ricorre per la stima trimestrale di un aggregato che concorre alla definizione dei Conti trimestrali per settore istituzionale è definito approccio indiretto e rappresenta un metodo di aggiustamento a 2 stadi in cui il dato annuale è trimestralizzato attraverso un indicatore disponibile ad alta frequenza. Una procedura di benchmarking è quindi già utilizzata nel processo di produzione dei dati trimestrali.

Per la produzione delle serie destagionalizzate, infine, si esegue generalmente l'identificazione, la stima e la rimozione della componente stagionale direttamente sugli indicatori di riferimento. Tuttavia ci sono degli aggregati per i quali le tecniche di destagionalizzazione si applicano direttamente all'aggregato trimestrale grezzo ovvero a quello ottenuto mediante la disaggregazione dei dati annuali con l'indicatore grezzo. In ogni caso la destagionalizzazione non assicura la consistenza dei dati destagionalizzati con il vincolo annuo.

Il ricorso alle tecniche di riconciliazione di seguito descritte garantisce la coerenza interna al complesso sistema di serie fin qui descritto.

3. Il problema della riconciliazione nei conti trimestrali istituzionali

Le rappresentazioni contabili, generalmente, necessitano sia di procedure di bilanciamento sia di *benchmarking*. Le procedure di bilanciamento rimuovono la discrepanza tra le variabili, quelle di *benchmarking* si occupano dell'aggiustamento interno alla dimensione temporale.⁶ Nell'ambito dei QSA (Quarterly Sector Accounts) nessun settore istituzionale è derivato a residuo, pertanto essi vanno riconciliati per rimuovere ogni possibile discrepanza nei dati.

Una procedura di riconciliazione automatica si rende necessaria in quanto ad ogni trimestre occorre tener conto dei seguenti vincoli:

- ASA (Annual Sectors Accounts):⁷ sono i conti annuali per settore istituzionale rilasciati nel mese di luglio dell'anno t ;
- QNA (Quarterly National Accounts):⁸ sono i conti trimestrali per il totale economia rilasciati a $t+70$ giorni dal trimestre di riferimento;
- QGGA (Quarterly General Government Accounts):⁹ sono i conti trimestrali per la pubblica amministrazione rilasciati a $t+90$ giorni dal trimestre di riferimento. I dati di questo settore sono integrati nei QSA e, oltre ad essere trasmessi ad Eurostat, sono diffusi a livello nazionale.

⁶ Si veda Bee Dagum e Cholette (2006), Di Fonzo (2003).

⁷ Le serie annuali degli ASA sono disponibili all'indirizzo:
http://www.istat.it/salastampa/comunicati/non_calendario/20100722_00/

⁸ Le serie trimestrali dei QNA sono disponibili all'indirizzo:
http://www.istat.it/salastampa/comunicati/in_calendario/contitri/20100910_00/

⁹ Le serie trimestrali della PA sono disponibili all'indirizzo:
http://www.istat.it/salastampa/comunicati/in_calendario/contoPA/20110110_00/

Con riferimento ai tre trimestri infrannuali, per ciascuna variabile è necessario assicurare che la somma dei settori istituzionali interni sia uguale al totale economia; mentre con riferimento al quarto trimestre oltre ad assicurare la somma dei settori istituzionali interni uguale al totale economia, per ciascuna variabile e per ciascun settore istituzionale va garantita la somma delle stime relative ai quattro trimestri che deve coincidere con le stime annuali.

Operativamente è come se si partisse da una matrice di dati preliminari ad alta frequenza da riconciliare con i *vincoli temporali* ovvero le stime annuali delle variabili di interesse (ASA) e con la serie ad alta frequenza che costituisce il *vincolo contemporaneo* (QNA) che deve essere garantito in ciascun periodo osservato.

Volendo schematizzare il problema attraverso una rappresentazione tabellare (Tav. 1): per un generico aggregato economico Y e per una generica branca di attività economica vale quanto segue ovvero che per ciascun istante temporale (il trimestre) deve valere che la somma dei settori società non finanziarie (SNF), società finanziarie (SFIN), famiglie (FT) e pubblica amministrazione (PA) deve coincidere con quanto stimato per il totale economia (TE).

Il generico elemento Y_{S,T,q_i} della tabella rappresenta la stima del trimestre q_i dell'anno T per il settore istituzionale S di un generico aggregato economico e per ciascun trimestre la somma della stima trimestrale di tutti i settori deve coincidere con la stima trimestrale Z_{TE,T,q_i} relativa al totale economia; inoltre per ciascun settore in corrispondenza del rilascio del quarto trimestre va garantita la coerenza con la stima annuale del settore $Y_{S,T}$ fornita dagli ASA.

La tavola 1 evidenzia, inoltre, che per i trimestri infrannuali q_1, q_2, q_3 quando non è disponibile il vincolo annuale ASA e si procede in estrapolazione si tiene conto soltanto del vincolo contemporaneo costituito dal totale economia fornito dai QNA.

Tavola 1 - Schema del problema della riconciliazione nei QSA

ANNO	TRIMESTRE	SNF	SFIN	FT	PA	TE
1	Q1	$Y_{SNF,1,q_1}$	$Y_{SFIN,1,q_1}$	$Y_{FT,1,q_1}$	$Y_{PA,1,q_1}$	$Z_{TE,1,q_1}$
	Q2	$Y_{SNF,1,q_2}$	$Y_{SFIN,1,q_2}$	$Y_{FT,1,q_2}$	$Y_{PA,1,q_2}$	$Z_{TE,1,q_2}$
	Q3	$Y_{SNF,1,q_3}$	$Y_{SFIN,1,q_3}$	$Y_{FT,1,q_3}$	$Y_{PA,1,q_3}$	$Z_{TE,1,q_3}$
	Q4	$Y_{SNF,1,q_4}$	$Y_{SFIN,1,q_4}$	$Y_{FT,1,q_4}$	$Y_{PA,1,q_4}$	$Z_{TE,1,q_4}$
	TOT	$Y_{SNF,1}$	$Y_{SFIN,1}$	$Y_{FT,1}$	$Y_{PA,1}$	$Z_{TE,1}$
2	Q1	$Y_{SNF,2,q_1}$	$Y_{SFIN,2,q_1}$	$Y_{FT,2,q_1}$	$Y_{PA,2,q_1}$	$Z_{TE,2,q_1}$
	Q2	$Y_{SNF,2,q_2}$	$Y_{SFIN,2,q_2}$	$Y_{FT,2,q_2}$	$Y_{PA,2,q_2}$	$Z_{TE,2,q_2}$
	Q3	$Y_{SNF,2,q_3}$	$Y_{SFIN,2,q_3}$	$Y_{FT,2,q_3}$	$Y_{PA,2,q_3}$	$Z_{TE,2,q_3}$
	Q4	$Y_{SNF,2,q_4}$	$Y_{SFIN,2,q_4}$	$Y_{FT,2,q_4}$	$Y_{PA,2,q_4}$	$Z_{TE,2,q_4}$
	TOT	$Y_{SNF,2}$	$Y_{SFIN,2}$	$Y_{FT,2}$	$Y_{PA,2}$	$Z_{TE,2}$
...	
T-1	Q1	$Y_{SNF,T-1,q_1}$	$Y_{SFIN,T-1,q_1}$	$Y_{FT,T-1,q_1}$	$Y_{PA,T-1,q_1}$	$Z_{TE,T-1,q_1}$
	Q2	$Y_{SNF,T-1,q_2}$	$Y_{SFIN,T-1,q_2}$	$Y_{FT,T-1,q_2}$	$Y_{PA,T-1,q_2}$	$Z_{TE,T-1,q_2}$
	Q3	$Y_{SNF,T-1,q_3}$	$Y_{SFIN,T-1,q_3}$	$Y_{FT,T-1,q_3}$	$Y_{PA,T-1,q_3}$	$Z_{TE,T-1,q_3}$
	Q4	$Y_{SNF,T-1,q_4}$	$Y_{SFIN,T-1,q_4}$	$Y_{FT,T-1,q_4}$	$Y_{PA,T-1,q_4}$	$Z_{TE,T-1,q_4}$
	TOT	$Y_{SNF,T-1}$	$Y_{SFIN,T-1}$	$Y_{FT,T-1}$	$Y_{PA,T-1}$	$Z_{TE,T-1}$
T	Q1	Y_{SNF,T,q_1}	Y_{SFIN,T,q_1}	Y_{FT,T,q_1}	Y_{PA,T,q_1}	Z_{TE,T,q_1}
	Q2	Y_{SNF,T,q_2}	Y_{SFIN,T,q_2}	Y_{FT,T,q_2}	Y_{PA,T,q_2}	Z_{TE,T,q_2}
	Q3	Y_{SNF,T,q_3}	Y_{SFIN,T,q_3}	Y_{FT,T,q_3}	Y_{PA,T,q_3}	Z_{TE,T,q_3}
	Q4	Y_{SNF,T,q_4}	Y_{SFIN,T,q_4}	Y_{FT,T,q_4}	Y_{PA,T,q_4}	Z_{TE,T,q_4}
	TOT	$Y_{SNF,T}$	$Y_{SFIN,T}$	$Y_{FT,T}$	$Y_{PA,T}$	$Z_{TE,T}$
	Q1	$Y_{SNF,T+1,q_1}$	$Y_{SFIN,T+1,q_1}$	$Y_{FT,T+1,q_1}$	$Y_{PA,T+1,q_1}$	$Z_{TE,T+1,q_1}$
	Q2	$Y_{SNF,T+1,q_2}$	$Y_{SFIN,T+1,q_2}$	$Y_{FT,T+1,q_2}$	$Y_{PA,T+1,q_2}$	$Z_{TE,T+1,q_2}$
	Q3	$Y_{SNF,T+1,q_3}$	$Y_{SFIN,T+1,q_3}$	$Y_{FT,T+1,q_3}$	$Y_{PA,T+1,q_3}$	$Z_{TE,T+1,q_3}$

4. Le metodologie di riconciliazione

4.1 Introduzione: il bilanciamento di matrici di dati

Il bilanciamento dei conti nazionali è una pratica diffusa ed applicata negli uffici statistici nazionali da diversi anni, a partire dai lavori pionieristici di Stone.¹⁰ Le procedure di bilanciamento dei dati devono risolvere un problema che può essere espresso nel modo seguente: data una matrice di grandezze P rettangolare o quadrata occorre trovare un'altra matrice finale Y , delle medesime dimensioni, in cui siano rispettate delle restrizioni lineari sui valori delle matrici stesse. Tipicamente le restrizioni implicano che le sommatorie per riga e/o per colonna debbano necessariamente eguagliare dei valori marginali, così ad esempio per ogni riga i potrebbe valere la seguente restrizione:

$$\sum_j y_{ij} = z_i \quad \forall i=1,2,\dots,r \quad (1)$$

con il vincolo espresso da un totale marginale di riga z_i ; al contempo, il medesimo discorso è valido per dei possibili vincoli di colonna: pertanto la necessità di una procedura di bilanciamento si pone quando l'espressione (1) non è rispettata anche per una sola riga i .

Vi sono diverse metodologie per risolvere il problema in questione; esse possono essere classificate in maniera molto sintetica in due modi:

- tecniche di *scaling*, che adottano un bilanciamento biproportionale costante sino ad esaurimento¹¹ delle discrepanze; uno dei metodi più noti è il RAS;
- algoritmi di ottimizzazione che si fondano sulla minimizzazione di funzioni obiettivo vincolate, sulla base di una metrica che misura la distanza fra la matrice di dati originaria e quella finale bilanciata: il criterio più utilizzato è quello dei minimi quadrati e l'approccio più noto è quello di Stone.

Il criterio RAS è una metodologia di riproporzionamento iterativo che sinteticamente può essere descritto nei seguenti passi:

- i dati di input sono la matrice P ($i \times j$) dei dati da riproporzionare ed i vincoli di riga e di colonna z_i e z_j ;
- passo zero: si pone $s = 0$, la matrice P è quindi uguale alla matrice da stimare al passo zero Y^0 ;
- passo 1: il riproporzionamento si effettua dapprima per riga, calcolando per ogni riga i un peso che misura la discrepanza fra ogni singolo elemento della matrice ed

il valore che rappresenta il vincolo di riga pari a $\lambda_i^s = \frac{z_i}{\sum_j y_{ij}^s}$, il quale si utilizza

per aggiornare i valori di ogni singola elemento dell'array ponendo

$$y_{ij}^s = \lambda_i^s y_{ij}^s \quad \forall i, j;$$

¹⁰ Si vedano Stone et al (1942) e Stone (1961).

¹¹ In realtà viene fissato un valore soglia, molto prossimo allo zero, sotto cui il processo iterativo si arresta.

- passo 2: si effettua il riproporzionamento per colonna, stimando il peso

$$\mu_j^s = \frac{z_j}{\sum_i y_{ij}^s}$$

sulla base del vincolo di colonna, con cui si definisce la matrice Y^{s+1} ,

in cui ogni cella è pari a $y_{ij}^{s+1} = \mu_j^s y_{ij}^s \quad \forall i, j$;

- si pone $s = s+1$ e si riparte dal passo 1, sino a quando le discrepanze (le somme per riga e per colonna che non coincidono con i vincoli) sono ridotte ad un valore prossimo allo zero.

La tecnica RAS è relativamente semplice da computare ed attivare in un processo operativo, ma possiede degli inconvenienti che ne limitano l'uso. Tali limiti in sintesi sono:

- la tecnica funziona anche con valori negativi, i quali spesso hanno scarso significato con grandezze economiche o statistiche;
- le restrizioni possono essere espresse come semplici sommatorie e non come una qualsiasi combinazione lineare, fattore che implica la stima di un sistema di pesi;
- ad ogni valore della matrice P è assegnato il medesimo grado di affidabilità prima del bilanciamento.

Nonostante tali limitazioni la metodologia è molto diffusa in quanto molto intuitiva e, come detto, relativamente semplice da introdurre in una procedura automatizzata.

La tecnica di Stone rientra fra le procedure di bilanciamento di dati che utilizzano i modelli di regressione. Il problema può essere formalizzato nel seguente modo: dati una matrice di dati preliminari vettorizzata p , una matrice di varianza-covarianza delle discrepanze V , ipotizzata diagonale:¹²

$$V = \begin{bmatrix} \sigma_{p1}^2 & 0 & \dots & 0 \\ 0 & \sigma_{p2}^2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \sigma_{pn}^2 \end{bmatrix}$$

un vettore incognita di dati bilanciati y , una matrice H di aggregazione,¹³ un vettore di vincoli z , e un vettore di moltiplicatori di Lagrange λ , la funzione lagrangiana da minimizzare è la seguente:

$$L = (y - p)'V(y - p) + 2\lambda(Hy - z) \tag{2}$$

¹² Quindi per costruzione è ipotizzata eteroschedasticità nei dati, pur mantenendo l'ipotesi di assenza di correlazione longitudinale.

¹³ La matrice H di aggregazione assume una conformazione diversa a seconda se i dati sono flussi o stocks.

Lo stimatore BLUE di Stone (ovvero quello non distorto a varianza minima fra quelli della classe degli stimatori lineari) assume la seguente forma:

$$y = p - VH'(H VH')^{-1}(Hp - z) \quad (3)$$

da cui si può vedere che i dati finali bilanciati sono uguali alle serie originarie corrette tramite una combinazione lineare del prodotto delle discrepanze ($Hp - z$) per una matrice di pesi. Moltiplicando ambo i membri della (3) per la matrice di aggregazione H si otterrà un'identità a posteriori $Hy = z$, relativamente ai vincoli. Questo stimatore può essere calcolato direttamente quando le dimensioni della matrice inversa di $H VH'$ sono contenute oppure quando essa è una matrice densa, altrimenti è necessario ricorrere a tecniche iterative, come ad esempio quella adottata per il bilanciamento dei conti annuali italiani, basata sul metodo del gradiente coniugato.¹⁴

La matrice di varianza-covarianza V è di fondamentale importanza per individuare la grandezza e la direzione degli aggiustamenti: essa misura l'accuratezza dei valori preliminari rispetto ai "veri" valori bilanciati; va ricordato però che gli elementi di questa matrice non sono noti, di conseguenza Stone ha ipotizzato che essi siano posti pari al rispettivo valore preliminare $\sigma_{pi}^2 = p_i$. Inoltre si può operare una valutazione soggettiva "a priori" sull'attendibilità, e quindi sul grado di fiducia, che si ripone nel singolo vettore dei dati preliminari, modificando il valore di p_i con un fattore di correzione θ_i , quindi si pone:

$$\sigma_{pi}^2 = \theta_i p_i \quad 0 < \theta_i \leq 1 \quad \forall i$$

a cui si può attribuire, convenzionalmente, un valore compreso fra zero ed uno in modo da dargli un'interpretazione probabilistica, ma ciò non è obbligatorio, ovvero si possono assegnare anche valori superiori ad uno senza inficiare la stima. Come si vedrà nella sezione 4.3, l'opportunità di attribuire un valore soggettivo al peso relativo dei dati preliminari si prospetta addirittura come necessaria nel caso dei conti trimestrali per settore istituzionale.

4.2 Il benchmarking: la metodologia di Denton

La procedura di di Denton è una tecnica di interpolazione dei dati che può essere utilizzata in diversi contesti. I più noti sono i seguenti:

- nel contesto delle metodologie di dissaggregazione temporale, che consentono la produzione di stime infrannuali (mensili o trimestrali), data una collezione di stime a frequenza temporale trimestrale o annuale; in questa sede supporremo che la relazione sia fra dati trimestrali ed annuali;
- nell'ambito di procedure di *benchmarking* o più in generale nelle tecniche di bilanciamento che contemplino la presenza di serie temporali.

Essa si basa sulla minimizzazione quadratica della differenza fra una serie preliminare ed una serie aggiustata.¹⁵ Tale differenza può essere additiva (sui livelli) o proporzionale

¹⁴ Si vedano Byron (1978) e Nicolardi (2000).

¹⁵ Per approfondimenti si vedano Denton (1971) e Bee Dagum e Cholette (2006).

(sugli aggiustamenti relativi): nella tavola 2 è riportata una tassonomia delle principali funzioni di perdita che si possono associare al metodo di Denton. Generalizzando il problema, occorre minimizzare la seguente funzione lagrangiana:

$$L = (y - p)'M(y - p) + 2\lambda(Hy - z)$$

con y serie finale, p serie preliminare, H è la consueta matrice di aggregazione, z il vettore dei vincoli stringenti, λ consueto vettore dei moltiplicatori di Lagrange, ed M è un operatore lineare simmetrico non singolare cui accenneremo in seguito.

Tavola 2 - Tipologia funzioni di perdita associate con il metodo di Denton

TIPOLOGIA FUNZIONE DI PERDITA	Formula
Naïve	$(y - p)$
Additive first difference (AFD)	$\Delta(y - p)$
Additive second difference (ASD)	$\Delta^2(y - p)$
Additive third difference (ATD)	$\Delta^3(y - p)$
Pro-rata	$\left(\frac{y - p}{p} \right)$
Proportional first difference (PFD)	$\Delta \left(\frac{y - p}{p} \right)$
Proportional second difference (PSD)	$\Delta^2 \left(\frac{y - p}{p} \right)$
Proportional third difference (PTD)	$\Delta^3 \left(\frac{y - p}{p} \right)$

Brevemente le condizioni del primo ordine sono:

$$\begin{cases} \frac{\partial L}{\partial y} = 2My - 2Mp + 2\lambda H = 0 \\ \frac{\partial L}{\partial \lambda} = Hy - z = 0 \end{cases}$$

e svolgendo gli opportuni passaggi algebrici si ottiene lo stimatore di Denton pari a:

$$y = p + MH'(HMH')^{-1}(z - Hp) \tag{4}$$

La matrice M può assumere diverse configurazioni a seconda della caratterizzazione della funzione di perdita definita nella funzione obiettivo e delle ipotesi assunte sul primo valore del periodo campionario.¹⁶ Ad esempio l'utilizzo di un *benchmarking* semplice, naïf, può comportare la presenza di un salto nelle serie, uno scalino fra il quarto trimestre di un anno ed il primo dell'anno successivo, a causa di una differenza sensibile fra valori annuali contigui: ciò accade quando la matrice M è definita come una matrice identità. L'introduzione di un operatore differenza a vari ordini interi, o conformazioni proporzionali della funzione di perdita, minimizzano o eliminano questo problema del salto di serie: ad esempio l'uso di una differenza prima $\Delta = 1 - L$, con L operatore ritardo (lag) tale che $\Delta y_t = y_t - y_{t-1}$, implica che la funzione di perdita additiva (AFD) sarà la seguente:

$$\kappa(p, y) = \sum_{t=1}^T (\Delta y_t - \Delta p_t)^2 = \sum_{t=1}^T [\Delta(y_t - p_t)]^2$$

In termini matriciali la trasformazione si esprime ponendo $M = D'D$, dove l'operatore differenza è così strutturato:

$$D = \begin{bmatrix} -1 & 1 & 0 & \cdots & 0 & 0 \\ 0 & -1 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & -1 & 1 \end{bmatrix}$$

Le procedure di *benchmarking* non possono non tener conto della struttura temporale dei dati in serie storica, intesi questi ultimi come realizzazione finita di un vettore aleatorio a componenti infinite. Un intervento combinatorio su un processo stocastico distorce, anzi inficia completamente le caratteristiche dinamiche intrinseche di tale processo. Il metodo di Denton, in special modo nella sua variante PFD, che agisce sui tassi di crescita, è caratterizzato dalla proprietà di preservare la dinamica, ovvero la serie finale y deve riprodurre, o al più salvaguardare nel miglior modo possibile, il movimento ed il segno della serie originale p o della sua variazione. Il *movement preservation principle* è una delle caratteristiche più importanti della procedura di Denton e proprietà numerica fondamentale nelle tecniche di riconciliazione di dati.

4.3 La riconciliazione di sistemi di serie storiche: soluzione simultanea ed approccio a due passi

La riconciliazione di serie storiche è un ambito di studi teorici che sintetizza entrambe le metodologie discusse nelle precedenti sezioni. L'esigenza di riportare ad una condizione di coerenza interna un insieme di dati, nasce dalla pratica degli uffici nazionali nella produzione delle statistiche ufficiali di un paese, che producono e rilasciano un sempre maggior numero di panel di serie storiche classificati in relazione ad

¹⁶ Si rimanda sempre a Bee Dagum e Cholette (2006), cap. 6.

un attributo merceologico, territoriale o un criterio funzionale, come ad esempio i settori istituzionali. Nel processo di stima dei dati intervengono delle condizioni dalle quali si originano delle discrepanze rispetto a delle stime predeterminate esogene, le quali assumono il rango di vincolo inviolabile, causate o dal dettaglio di disaggregazione longitudinale a cui i dati sono compilati, oppure determinate da trasformazioni funzionali quali ad esempio:

- una cattiva specificazione delle stime ad un definito livello di disaggregazione;¹⁷
- la pratica della destagionalizzazione, utilizzata per rimuovere la componente stagionale nei dati congiunturali;¹⁸
- l'applicazione diretta di una procedura di *benchmarking*, per bilanciare serie temporali;
- un processo di interpolazione o di disaggregazione temporale, prassi utilizzata nella stima dei conti nazionali trimestrali quando si adotta una procedura indiretta, in assenza di dati direttamente disponibili;
- l'uso di modelli previsivi in totale assenza di una base informativa relativa alla variabile oggetto di stima.

Come affermato nella sezione 3, la stima trimestrale dei conti istituzionali è un ottimo paradigma della situazione ivi illustrata; alcuni aggregati sono prodotti a 32 branche di attività economica per ogni settore istituzionale e tutti e cinque i punti summenzionati possono intervenire nella filiera produttiva delle stime di tali conti, i quali necessariamente devono essere ricondotti in ogni trimestre sia ai valori delle stime dei conti trimestrali (per grandezze come ad esempio l'occupazione o i redditi), sia alle stime annuali per settore istituzionale, relativamente alle stesse variabili. Di conseguenza sono attivi due vincoli mentre, per i trimestri stimati in estrapolazione relativamente all'anno in corso non disponibile, è attivo il solo vincolo trimestrale. Le specifiche difficoltà nascono dal fatto che i dati possiedono una dimensione temporale ed una spaziale-sezionale, le quali richiedono un trattamento *ad hoc* per preservare al meglio la struttura informativa degli stessi.

I fattori che influenzano l'uso di un approccio simultaneo nella risoluzione di un sistema di serie storiche sono il numero delle serie e delle variabili (branche o distretti territoriali o settori istituzionali ad esempio), l'ampiezza del periodo campionario ed infine il numero dei vincoli operanti. Formalizziamo la questione considerando:

- m serie storiche da riconciliare;
- k unità longitudinali;
- n serie ad alta frequenza;
- N serie a bassa frequenza;
- s ordine di aggregazione temporale.

¹⁷ Qui entra in gioco la questione dell'aggregation bias, introdotta dall'aggregazione di stime risultanti da micromodelli stocastici contrapposta all'aggregation gain (cfr. Barker e Pesaran, 1990).

¹⁸ Questa prassi è giustificabile, anche se dipende dagli obiettivi della stima e dai fruitori dei dati: i cosiddetti dati grezzi possono essere più informativi in alcuni contesti, in particolare da quando la teoria dei sistemi dinamici, il paradigma della complessità e del caos hanno aperto la disciplina statistica ed econometrica a nuovi sviluppi. Il trattamento e la stima di dati possono essere condotti con modelli parametrici non lineari la cui generalizzazione è rappresentata dallo sviluppo in serie di Volterra (cfr. Granger e Teräsvirta, 1993).

Per stimare in modalità simultanea un sistema di serie storiche occorre risolvere un problema multivariato di minimizzazione quadratica vincolata come il seguente:

$$\begin{aligned} \arg \min (R-P)' \Omega (R-P) \\ \text{sub } HR = Y_a \end{aligned} \quad (5)$$

dove con R denotiamo le serie finali riconciliate (vettore di dimensione $nm \times I$), con P ($nm \times I$) le serie preliminari da sottoporre a bilanciamento, H (dimensione $kn+Nm \times nm$) è una matrice di aggregazione partizionata che contiene tutti i vincoli ed infine Y_a (dimensione $kn+Nm \times I$) è la variabile che esprime i vincoli opportunamente vettorizzati.¹⁹ La matrice di varianza-covarianza Ω , è espressione di una differenza prima proporzionale fra dato riconciliato e valore preliminare (*Proportional First Differences*, PFD):

$$\sum_{j=1}^M \sum_{t=2}^n \left(\frac{R_{j,t} - P_{j,t}}{P_{j,t}} - \frac{R_{j,t-1} - P_{j,t-1}}{P_{j,t-1}} \right)^2 = \sum_{j=1}^M \sum_{t=2}^n \left(\frac{R_{j,t}}{P_{j,t}} - \frac{R_{j,t-1}}{P_{j,t-1}} \right)^2$$

che, come già accennato, assicura la conservazione della dinamica, ed assume la seguente formulazione:

$$\Omega = \hat{P}^{-1} (I_m \otimes \Delta'_n \Delta_n) \hat{P}^{-1}$$

la quale a sua volta risulta come prodotto tensoriale della matrice identità di dimensione I_m , per la matrice Δ_n (di dimensione $(n-1) \times n$) operatore differenza prima,²⁰ che possiede la seguente forma:

$$\Delta_n = \begin{bmatrix} -1 & 1 & 0 & \cdots & 0 & 0 \\ 0 & -1 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & -1 & 1 \end{bmatrix}$$

e dell'inversa della matrice $\hat{P} = \text{diag}(P)$.

Le condizioni del primo ordine dell'intero sistema sono:

$$\begin{bmatrix} \Omega & H' \\ H & 0 \end{bmatrix} \begin{bmatrix} R \\ \lambda \end{bmatrix} = \begin{bmatrix} \Omega P \\ Y_a \end{bmatrix}$$

¹⁹ Per i dettagli si vedano Bee Dagum e Cholette (2006) e Di Fonzo e Marini (2009).

²⁰ Tale matrice può assumere altre configurazioni, per approfondimenti si veda sempre Bee Dagum e Cholette (2006), cap.6.

La soluzione simultanea conduce al consueto stimatore che è espresso dalla seguente formula:

$$R = P + \Omega^{-1}H'(H\Omega^{-1}H')^{-1} (Y_a - HP) \quad (6)$$

La matrice Ω , ponendo $I_m=1$, ed ipotizzando frequenza trimestrale dei dati ($s = 4$), assume la seguente forma:

$$\Omega = \begin{bmatrix} \frac{1}{p_1^2} & -\frac{1}{p_1 p_2} & 0 & 0 \\ -\frac{1}{p_2 p_1} & \frac{2}{p_2^2} & -\frac{1}{p_2 p_3} & 0 \\ 0 & -\frac{1}{p_3 p_2} & \frac{2}{p_3^2} & -\frac{1}{p_3 p_4} \\ 0 & 0 & -\frac{1}{p_4 p_3} & \frac{1}{p_4^2} \end{bmatrix}$$

Lo stimatore possiede la nota struttura di correzione del dato preliminare P attraverso la distribuzione di una combinazione lineare delle discrepanze, con $(H\Omega^{-1}H')^{-1} = \Lambda$ matrice inversa generalizzata di Moore-Penrose. Inoltre tale matrice è una matrice sparsa, quindi presenta un'alta densità di valori nulli, e singolare (a causa di osservazioni ridondanti) per costruzione. Come è usuale in tutte le procedure di bilanciamento *tout court*, la dimensione della matrice partizionata inversa può essere fonte di problemi computazionali di un certo rilievo. Oltre un certo ordine di grandezza delle variabili coinvolte le dimensioni della matrice Λ , e delle osservazioni da elaborare, crescono esponenzialmente. In una procedura automatizzata si possono utilizzare algoritmi di calcolo o metodi diretti di risoluzione di sistemi lineari con matrici sparse, che impiegano ad esempio metodi di fattorizzazione delle matrici come la decomposizione QR.

Qualora non si volesse adottare una soluzione basata sulla fattorizzazione della matrice Λ , Quenneville e Rancourt (2005) hanno proposto una soluzione a due passi per la risoluzione di sistemi vincolati di serie storiche che può interpretarsi in termini di minimi quadrati ponderati (*Weighted Least Squares*). Tale procedura di riconciliazione a due passi (d'ora in avanti 2SR, *2-steps reconciliation*) è stata in seguito generalizzata e si articola di regola come segue:

- 1° step: si effettua un *benchmarking* univariato, quindi su una serie storica alla volta, per ristabilire l'additività temporale annuale, adottando la procedura di Denton, la quale, come sottolineato, se considerata nella sua variante PFD, assicura la proprietà di conservazione della dinamica;
- 2° step: si può adottare una riconciliazione con il metodo di Stone (o pro-rata bidimensionale o aggiustamento con minimi quadrati), un anno (quattro trimestri) alla volta.

Il secondo passo suggerisce la soluzione del problema numerico: la gestione di un bilanciamento un anno, o pochi anni, alla volta abbatte notevolmente il numero di incognite, aggirando i problemi di singolarità della matrice Λ e velocizzando i tempi di esecuzione della stima.

Introducendo la procedura di bilanciamento di Stone abbiamo menzionato la possibilità di intervenire sui valori della matrice di varianza-covarianza Ω che entra nel calcolo dello stimatore. Anche in questo stimatore è possibile applicare dei coefficienti di affidabilità o di alterabilità alle serie in oggetto. Nella stima trimestrale per settore istituzionale essi vanno interpretati più come grado di libertà negli aggiustamenti piuttosto che come misura della fiducia riposta nei confronti delle stime preliminari: tale assegnazione risulta addirittura imprescindibile, in quanto le stime relative ad alcuni settori istituzionali e/o alcune branche non possono essere in alcuna misura alterate in quanto già stimate o rilasciate nel contesto di altri domini.²¹ Ciò permette di alterare la misura della distribuzione degli aggiustamenti in relazione alla dispersione interna (*within*) piuttosto che esterna (*between*). Convenzionalmente il campo di variazione di questi coefficienti è posto fra zero ed uno: facciamo notare che nella realtà operativa il valore dei coefficienti di affidabilità deve essere prossimo a zero ma non nullo, altrimenti c'è il rischio di incorrere nella singolarità dell'inversa di Ω . L'operatore Ω , per costruzione, presenta eteroschedasticità e correlazione dei dati, quindi è possibile attribuire dei coefficienti di alterabilità anche al di fuori della diagonale principale.

4.4 Misure di discrepanza e di aggiustamento

Al fine di poter individuare la grandezza del fenomeno e fare dei confronti fra le metodologie disponibili, definiamo una misura delle discrepanze pre-riconciliazione con il seguente indice τ che esprime la grandezza percentuale della differenza fra la stima del totale dei settori istituzionali rispetto al *benchmark* (il vincolo contemporaneo, che potrebbe essere il totale marginale di riga z_i):

$$\tau = \frac{\sum_k y_{ik} - z_i}{z_i}$$

Date le serie riconciliate R_j e preliminari P_j , ed i rispettivi tassi di crescita r_j e p_j , definiamo degli indici che danno una misura degli aggiustamenti sui valori assoluti e sui tassi di crescita, espressi in termini percentuali. Di conseguenza definiamo lo *Mean Squared Percentage Adjustment* (MSPA) sui livelli:

$$MSPA(R_j, P_j) = 100 \times \left[\frac{1}{n} \sum_{t=1}^n \left(\frac{R_{jt}}{P_{jt}} - 1 \right)^2 \right]^{1/2}$$

²¹ Ad esempio le stime relative alla branca 28 del settore istituzionale della Pubblica Amministrazione.

ed il suo corrispettivo sui tassi di crescita *Mean Squared Adjustment*:

$$MSA(r_j, p_j) = 100 \times \left[\frac{1}{n-1} \sum_{t=2}^n (r_{jt} - p_{jt})^2 \right]^{1/2}$$

dove r_{jt} e p_{jt} sono i tassi di crescita delle serie preliminari e riconciliate:

$$r_{jt} = \frac{R_{jt} - R_{jt-1}}{R_{jt-1}} \quad p_{jt} = \frac{P_{jt} - P_{jt-1}}{P_{jt-1}}$$

5. Un'applicazione: le unità di lavoro equivalenti a tempo pieno (ULA) per settore istituzionale

I conti trimestrali per settore istituzionale coinvolgono la stima di una notevole mole di variabili per sei settori istituzionali. Per alcune di queste variabili, come ad esempio l'occupazione, la stima è articolata a trentadue branche di attività economica, due tipologie di condizione professionale (dipendenti ed indipendenti), in modalità grezza e destagionalizzata. In questa sede vengono riportati i risultati di una procedura di riconciliazione a due passi in cui vengono confrontati gli esiti relativi a due procedure che si differenziano solo nel secondo passo in cui viene eseguito un bilanciamento. Quella che abbiamo denominato strategia 2SR si articola nei due seguenti passi:

- 1° passo: *benchmarking* univariato con procedura di Denton, sulle differenze prime proporzionali (PFD);
- 2° passo: selezione di coefficienti di affidabilità per le unità longitudinali e riconciliazione con vincoli annuali e contemporanei, attraverso una procedura dei minimi quadrati, con matrice di varianza-covarianza proporzionale al quadrato delle serie preliminari.

La strategia che definiamo RAS, invece adotta nel secondo passo un bilanciamento iterativo biproportionale, a seguito di un *benchmarking* con Denton nel primo step.

La variabile prescelta per la stima è la più rappresentativa delle grandezze che determinano l'occupazione: le Unità di lavoro equivalenti a tempo pieno (ula, da ora in avanti). Le ula sono una delle grandezze utilizzate come misura più adeguata del lavoro umano applicato alla produzione di valore nell'ambito della contabilità nazionale; esse nel Sistema Europeo dei Conti (SEC) sono definite come segue "l'occupazione equivalente a tempo pieno, che è pari al numero di posizioni lavorative equivalenti a tempo pieno, è definita come il quoziente tra il totale delle ore lavorate e la media annuale del numero di ore lavorate in posizioni lavorative a tempo pieno nel territorio economico²²". In riferimento sempre alle definizioni del SEC aggiungiamo che "sebbene il totale delle ore lavorate costituisca il miglior parametro per la misurazione degli input

²² Cfr. Eurostat (1996), p. 265.

di lavoro, l'equivalenza a tempo pieno presenta il vantaggio di essere più semplice da calcolare, ciò che facilita i confronti internazionali con i paesi che possono stimare soltanto l'occupazione equivalente a tempo pieno". La stima delle uls si trova a monte del processo di produzione delle statistiche trimestrali per settore istituzionale, essendo necessaria sia al computo di alcune grandezze pro-capite, ed al contempo, come coefficiente di espansione all'universo. Oggetto di stima sono le uls trimestrali lorde per settore istituzionale, dove l'aggettivo lorde indica che si considera l'occupazione a tempo pieno considerando nel computo la *Cassa Integrazione Guadagni* e le cosiddette posizioni lavorative *part-time*.²³

L'applicazione empirica che qui proponiamo riporta quindi le uls lorde a frequenza trimestrale destagionalizzate,²⁴ relative al lavoro dipendente, stimate a 32 branche, ma in seguito aggregate a sei macrobranche esclusivamente per semplicità espositiva. Il periodo campionario considerato è di ampiezza 1991:1-2008:4. Le stime relative alla disaggregazione temporale ed alla riconciliazione²⁵ sono state svolte nell'ambiente ModelEasy+, la procedura di destagionalizzazione è stata realizzata con TRAMO-SEATS (release 5.0) nella versione installata su ModelEasy+, mentre tutta la fase di elaborazione successiva alle stime suddette ed i grafici sono stati eseguiti con la nota piattaforma *open source* R (release 2.9.0).²⁶

Per dare una misura dell'ordine di grandezza delle poste nella tavola 3 sono riportati i valori delle uls lorde dipendenti destagionalizzate distinte per settore istituzionale e branca, prima e dopo la procedura di riconciliazione, e le relative differenze assolute, relativamente all'anno 2008: nonostante i dati facciano riferimento all'ultimo anno del campione, in cui le discrepanze sono state meno rilevanti, si ha un totale di circa 11000 uls redistribuite fra i settori.

²³ Per qualsiasi definizione statistica relativa al sistema dei conti nazionali si faccia riferimento al già citato SEC95 ed a ISTAT (2004).

²⁴ La procedura di destagionalizzazione al momento utilizzata nei paesi appartenenti all'UE è TRAMO-SEATS, per una panoramica su questa metodologia si veda Maravall (1995).

²⁵ La procedura di riconciliazione dei dati dell'occupazione per settore istituzionale utilizza un procedimento a due passi, con codice scritto da Marco Marini nel linguaggio SpeakEasy.

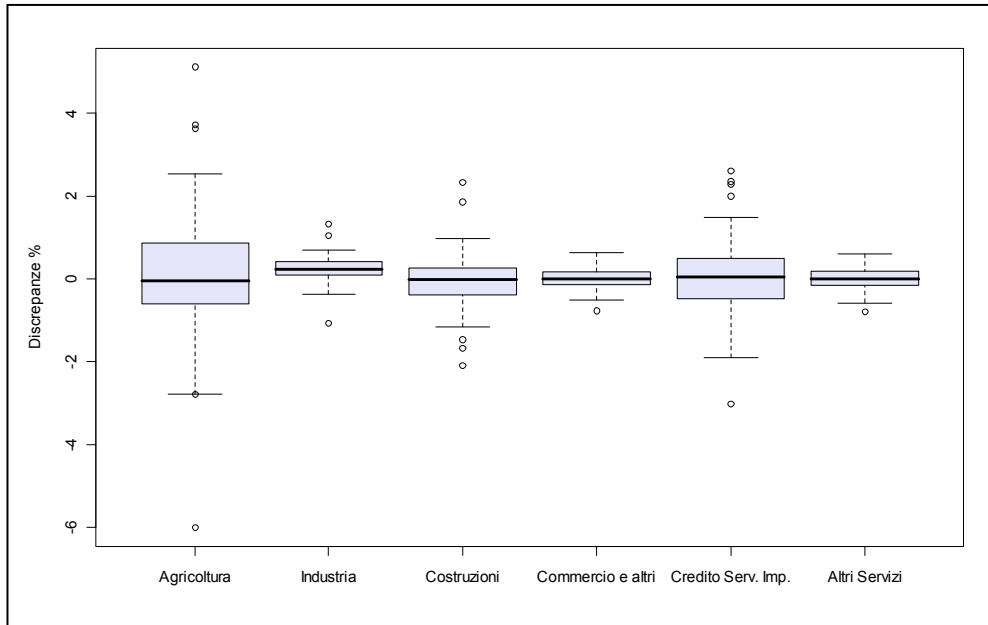
²⁶ URL <http://www.R-project.org>. Tale piattaforma, oltre a possedere un proprio linguaggio di programmazione di alto livello, presenta una vasta collezione di librerie matematiche e statistiche.

Tavola 3 - Valori assoluti delle ula lorde dipendenti destagionalizzate per settore istituzionale e branca, anno 2008: dati pre-riconciliazione, post-riconciliazione e differenze assolute

DATI SERIE PRELIMINARI							
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Imp.	PA altri Serv.	Totale Sett. Isti.
SNF	231994	4212161	1029788	3974463	1750535	688655	11887596
SF	0	588	0	0	518106	0	518694
PA	1554	6004	2650	15868	112992	3515018	3654086
FC	0	0	0	0	0	935974	935974
FP	245473	187666	264796	554095	193137	171829	1616996
ISP	7079	13747	1229	7906	10208	623020	663189
Totale branca	486100	4420166	1298463	4552332	2584978	5934496	19276535
DATI SERIE RICONCILIATE							
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Imp.	PA altri Serv.	Totale Sett. Isti.
SNF	232155	4203068	1029956	3976654	1750516	688209	11880558
SF	0	588	0	0	518106	0	518694
PA	1554	6005	2650	15868	111954	3515018	3653049
FC	0	0	0	0	0	936017	936017
FP	245527	187000	264959	553446	193101	171688	1615721
ISP	7079	13724	1229	7914	10207	621753	661906
Totale branca	486315	4410385	1298794	4553882	2583884	5932685	19265945
DIFFERENZE							
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Imp.	PA altri Serv.	Totale Sett. Isti.
SNF	161	-9093	168	2191	-19	-446	-7038
SF	0	0	0	0	0	0	0
PA	0	1	0	0	-1038	0	-1037
FC	0	0	0	0	0	43	43
FP	54	-666	163	-649	-36	-141	-1275
ISP	0	-23	0	8	-1	-1267	-1283
Totale branca	215	-9781	331	1550	-1094	-1811	-10590

Fonte: Elaborazione su dati Istat

Dal boxplot inserito nella figura 1 si può inferire immediatamente l'ordine di grandezza e la distribuzione delle discrepanze pre-riconciliazione: l'agricoltura, le costruzioni ed il credito sono quelle che presentano maggiore dispersione ed il più alto numero di valori anomali; l'ampiezza delle discrepanze dipende probabilmente dalla numerosità delle branche che entrano nell'aggregazione da 32 a 6 e dalla distribuzione delle discrepanze interna alle singole macrobranche.

Figura 1 - Boxplot della distribuzione delle discrepanze pre-riconciliazione per branca

Fonte: Elaborazione su dati Istat

Nelle tavole 4 e 5 sono riportati i valori delle misure di aggiustamento definite nella sezione 4.4, distinte per settore istituzionale e branca; da esse si può constatare come, sui dati disaggregati c'è una sostanziale parità fra i due metodi, mentre ragionando sui tassi di crescita c'è una netta prevalenza della strategia 2SR. Valutando l'impatto della riconciliazione sul dato aggregato per branche, è chiara una preminenza dell'approccio 2SR sui livelli e sui tassi di crescita (vedi Tav. 6).

Nelle tavole 7 e 8 viene comparato l'impatto che la modifica dei coefficienti di alterabilità ha sulle misure di aggiustamento; esso è stato condotto puramente a scopo didattico perché nella realtà operativa è stata già menzionata la necessità di lasciare inalterate determinate serie temporali relativamente ad alcuni settori istituzionali, scaricando tuttavia in tal modo sugli altri settori l'onere della riconciliazione. Ai settori istituzionali Società Non Finanziarie e Famiglie Produttrici è assegnato il valore massimo ($\theta = 1$) mentre agli altri settori è attribuito un valore di $\theta = 0.0001$: ad esempio, l'attribuzione di un coefficiente $\theta = 1$ anche alla PA e alle ISP, modifica la distribuzione degli aggiustamenti, il loro impatto sui settori istituzionali e sulle macrobranche, e di conseguenza, l'efficienza relativa degli indici.

Tavola 4 - Indice MSPA: valori per settore istituzionale e branca

MSPA 2SR						
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Impr.	PA altri Serv.
SNF	1.20	0.42	0.82	0.32	1.32	0.85
SF	-	0.00	-	-	0.59	-
PA	0.00	0.03	0.16	0.00	0.91	0.00
FC	-	-	-	-	-	1.20
FP	1.90	0.48	0.42	0.13	0.24	0.23
ISP	0.02	0.29	0.00	0.27	0.03	0.41

MSPA RAS						
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Impr.	PA altri Serv.
SNF	1.53	0.40	0.70	0.28	1.02	0.96
SF	-	0.34	-	-	1.02	-
PA	0.02	0.03	0.15	0.00	0.91	0.01
FC	-	-	-	-	-	0.90
FP	1.70	0.58	0.79	0.31	1.03	0.91
ISP	0.03	0.28	0.01	0.26	0.03	0.38

Fonte: Elaborazione su dati Istat

Tavola 5 - Indice MSA: valori per settore istituzionale e branca

MSA 2SR						
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Impr.	PA altri Serv.
SNF	1.74	0.55	0.98	0.48	1.63	1.25
SF	-	0.00	-	-	0.72	-
PA	0.00	0.01	0.10	0.00	0.04	0.00
FC	-	-	-	-	-	1.79
FP	2.50	0.10	0.27	0.08	0.26	0.33
ISP	0.00	0.10	0.00	0.07	0.01	0.16

MSA RAS						
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Impr.	PA altri Serv.
SNF	2.21	0.53	0.84	0.43	1.26	1.43
SF	-	0.53	-	-	1.26	-
PA	0.02	0.01	0.13	0.00	0.04	0.01
FC	-	-	-	-	-	1.35
FP	2.20	0.55	0.86	0.43	1.27	1.35
ISP	0.02	0.17	0.01	0.10	0.02	0.26

Fonte: Elaborazione su dati Istat

Tavola 6 - Confronto indici di aggiustamento per metodologie 2SR-RAS e per settore istituzionale

	MSPA						Tot
	SNF	SF	PA	FC	FP	ISP	
2SR	0.90	0.24	0.38	1.20	0.83	0.23	0.58
RAS	0.92	0.44	0.38	0.90	0.98	0.22	0.62

	MSA						Tot
	SNF	SF	PA	FC	FP	ISP	
2SR	1.21	0.29	0.05	1.79	1.04	0.08	0.73
RAS	1.27	0.56	0.06	1.35	1.26	0.13	0.80

Fonte: Elaborazione su dati Istat

Tavola 7 - Confronto indici MSPA per settore istituzionale e branca

	MSPA 2SR (Coeff. Alterabilità PA-ISP=0.0001)					
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Imp.	PA altri Serv.
SNF	1.20	0.42	0.82	0.32	1.32	0.85
SF	-	0.00	-	-	0.59	-
PA	0.00	0.03	0.16	0.00	0.91	0.00
FC	-	-	-	-	-	1.20
FP	1.90	0.48	0.42	0.13	0.24	0.23
ISP	0.02	0.29	0.00	0.27	0.03	0.41

	MSPA 2SR (Coeff. Alterabilità =1)					
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Imp.	PA altri Serv.
SNF	1.23	0.41	0.80	0.30	1.32	0.33
SF	-	0.00	-	-	0.60	-
PA	0.01	0.03	0.16	0.00	0.91	0.38
FC	-	-	-	-	-	0.09
FP	1.93	0.48	0.42	0.13	0.24	0.08
ISP	0.04	0.29	0.00	0.27	0.03	0.40

Fonte: Elaborazione su dati Istat

Tavola 8 - Confronto indici MSA per settore istituzionale e branca, per differenti valori dei coefficienti di alterabilità

MSA 2SR (Coeff. di Alterabilità PA-ISP=0.0001)						
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Imp.	PA altri Serv.
SNF	1.74	0.55	0.98	0.48	1.63	1.25
SF	-	0.00	-	-	0.72	-
PA	0.00	0.01	0.10	0.00	0.04	0.00
FC	-	-	-	-	-	1.79
FP	2.50	0.10	0.27	0.08	0.26	0.33
ISP	0.00	0.10	0.00	0.07	0.01	0.16

MSA 2SR (Coeff. Alterabilità =1)						
	Agricoltura	Industria	Costruzioni	Comm. Alb.	Cred. Serv. Imp.	PA altri Serv.
SNF	1.79	0.55	0.94	0.45	1.62	0.16
SF	-	0.00	-	-	0.71	-
PA	0.01	0.01	0.10	0.00	0.11	0.57
FC	-	-	-	-	-	0.12
FP	2.55	0.10	0.26	0.07	0.26	0.02
ISP	0.04	0.10	0.00	0.07	0.02	0.18

Fonte: Elaborazione su dati Istat

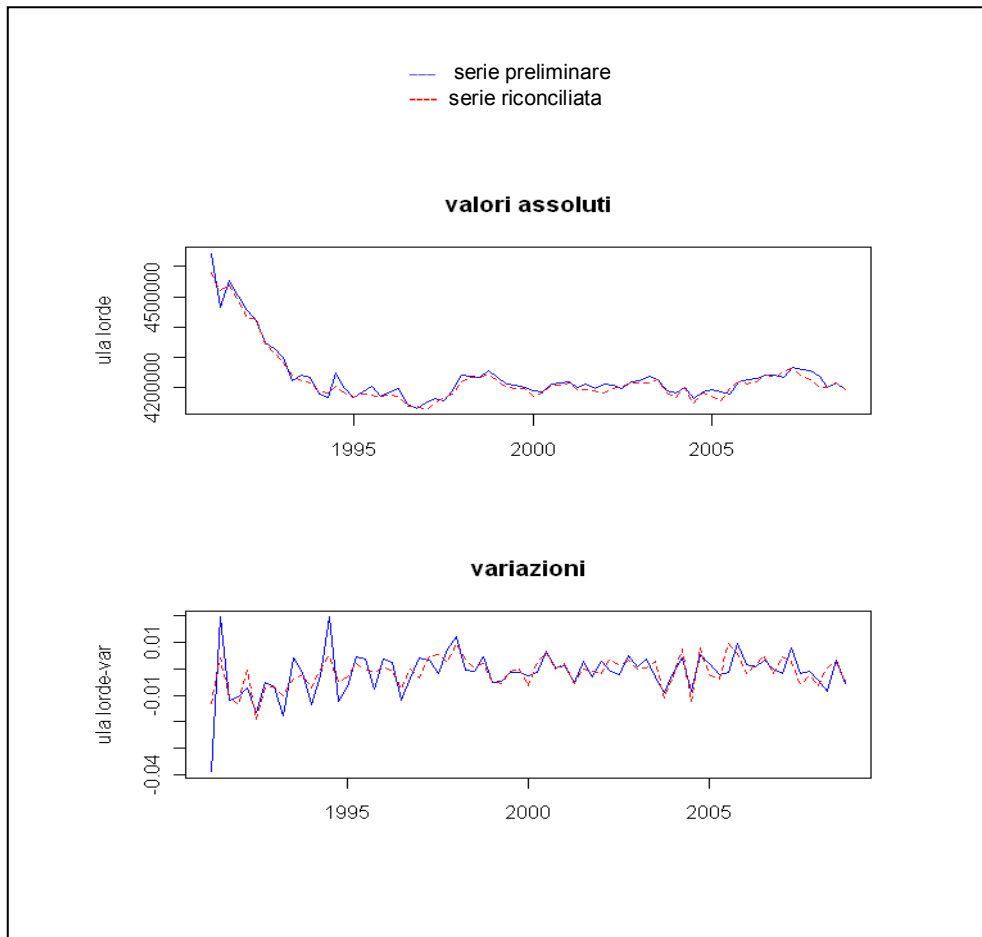
Nella figura 2 sono riportate le serie preliminari e riconciliate relative al comparto ed al settore istituzionale che possiede i valori e gli aggiustamenti più grandi (l'industria in senso stretto delle Società Non Finanziarie), dalla quale risulta immediatamente che la grandezza delle discrepanze pre-bilanciamento, in alcune finestre campionarie, non è affatto marginale e la procedura di riconciliazione può avere un impatto notevole nel ricondurre i dati ai vincoli trimestrale ed annuale.

Nelle figure 3-4 sono inoltre riprodotti i grafici delle serie dei tassi di crescita per le sei macrobranche relativamente ai due settori istituzionali (società non finanziarie e famiglie produttrici) a cui sono assegnati necessariamente, o meno, i maggiori aggiustamenti relativi nella riconciliazione: si può vedere chiaramente come nel settore istituzionale famiglie produttrici la metodologia 2SR presenta una minore volatilità dei tassi di variazione rispetto al RAS.

In conclusione, questa verifica empirica sembra dare delle indicazioni che sintetizziamo nei seguenti punti:

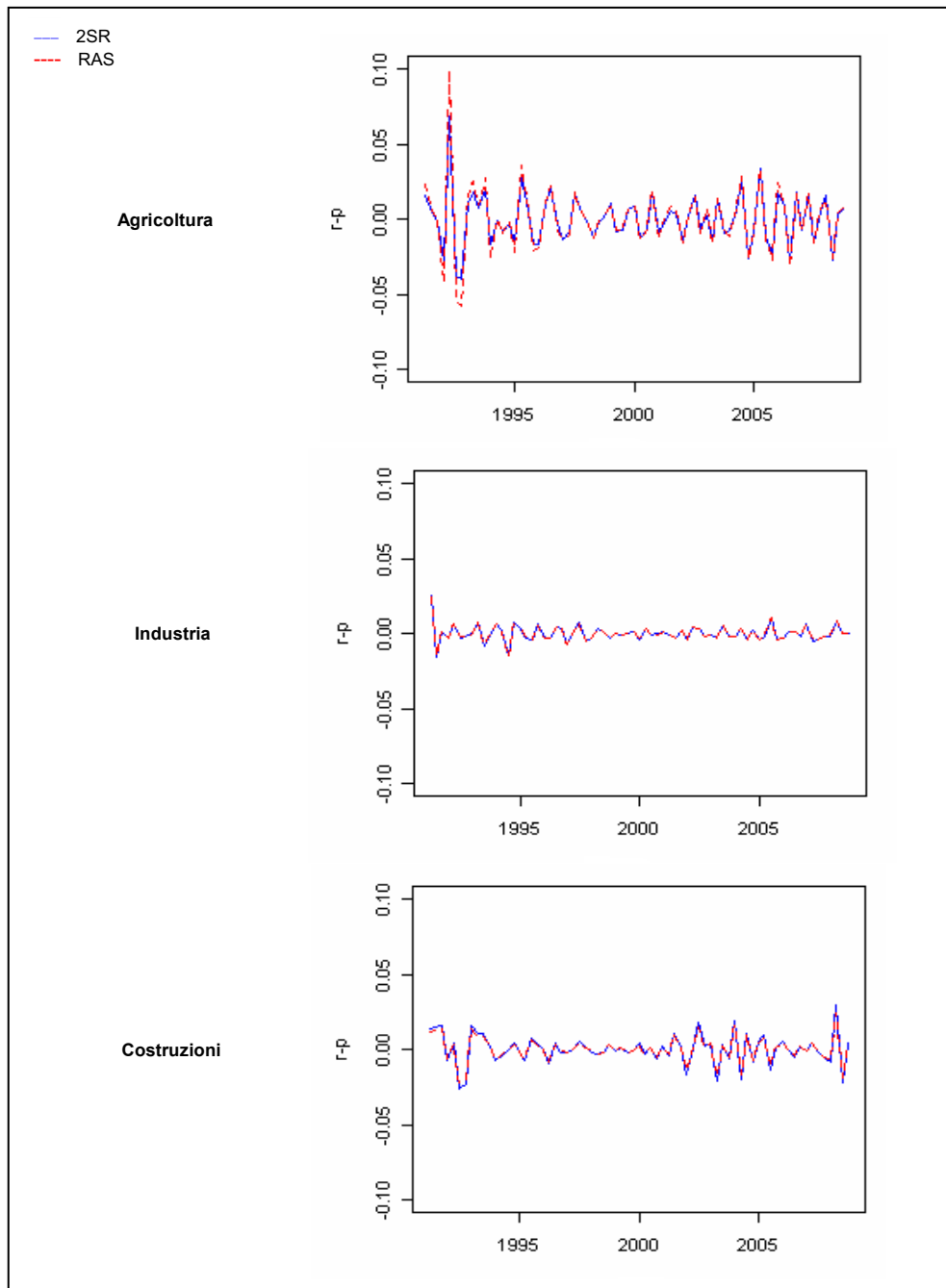
- la metodologia 2SR dà risultati soddisfacenti in termini assoluti e sui tassi di crescita rispetto alla metodologia alternativa RAS, sia per i singoli settori istituzionali che nella sua globalità;
- la calibrazione dei coefficienti di affidabilità, che ha un impatto sui valori degli indici di aggiustamento, va valutata anche in relazione alle revisioni delle serie, che nella stima dell'occupazione totale e per settore istituzionale riguarda gli ultimi 12 trimestri nel caso di dati grezzi, e l'intero periodo campionario nel caso di serie destagionalizzate;
- sviluppi futuri: è auspicabile l'introduzione nelle istituzioni che producono dati ufficiali della procedura in linguaggi e piattaforme più moderne e diffuse (R, Matlab, Octave ad esempio), sia in relazione all'efficienza operativa che in un'ottica di risparmio economico per la pubblica amministrazione.

Figura 2 - Serie temporale delle ula lorde dipendenti destagionalizzate: Società non finanziarie - branca Industria

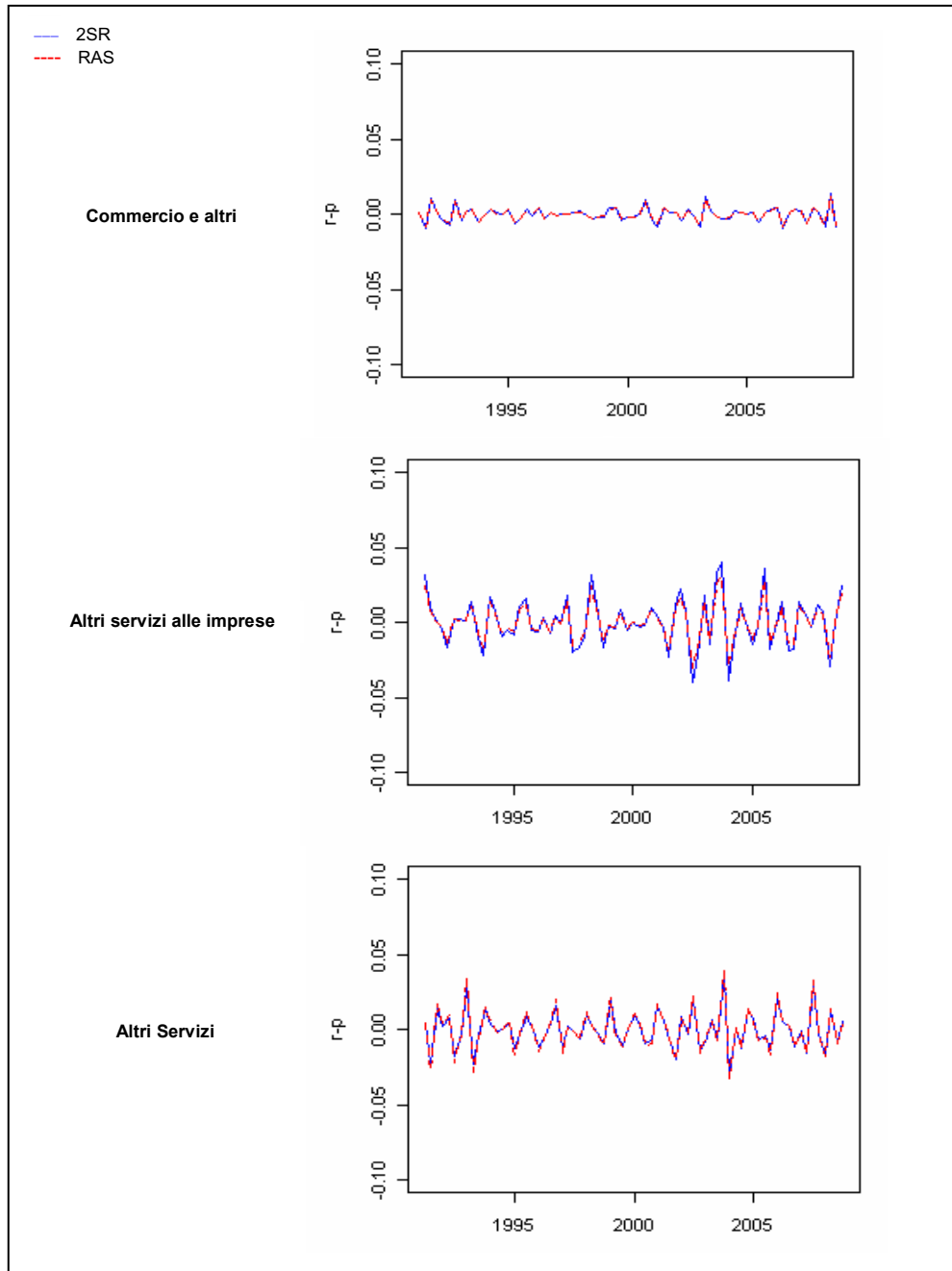


Fonte: Elaborazione su dati Istat

**Figura 3 - Serie temporali degli aggiustamenti nei tassi di crescita delle ula lorde destagionalizzate:
Società non finanziarie**

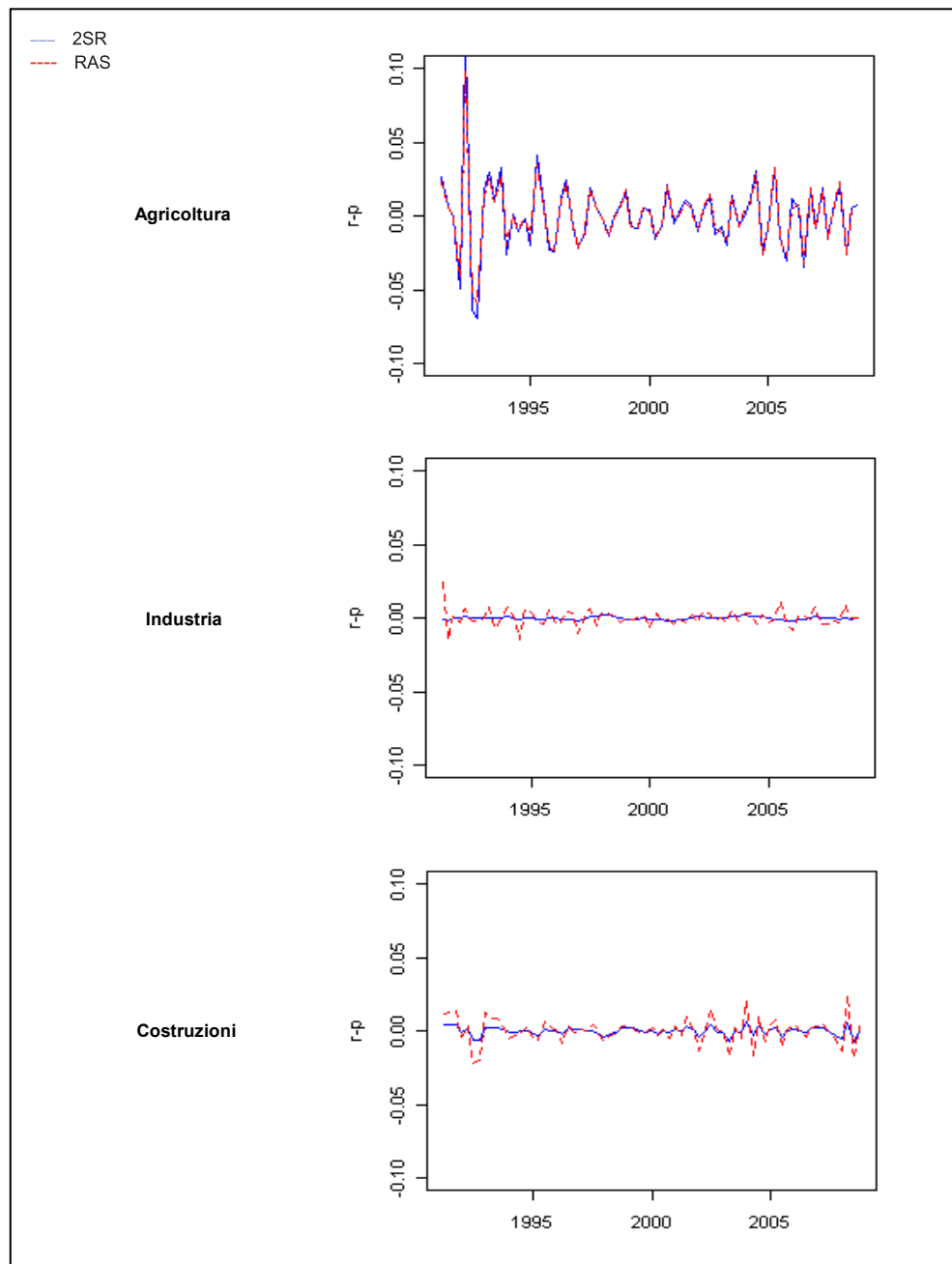


Fonte: Elaborazione su dati Istat

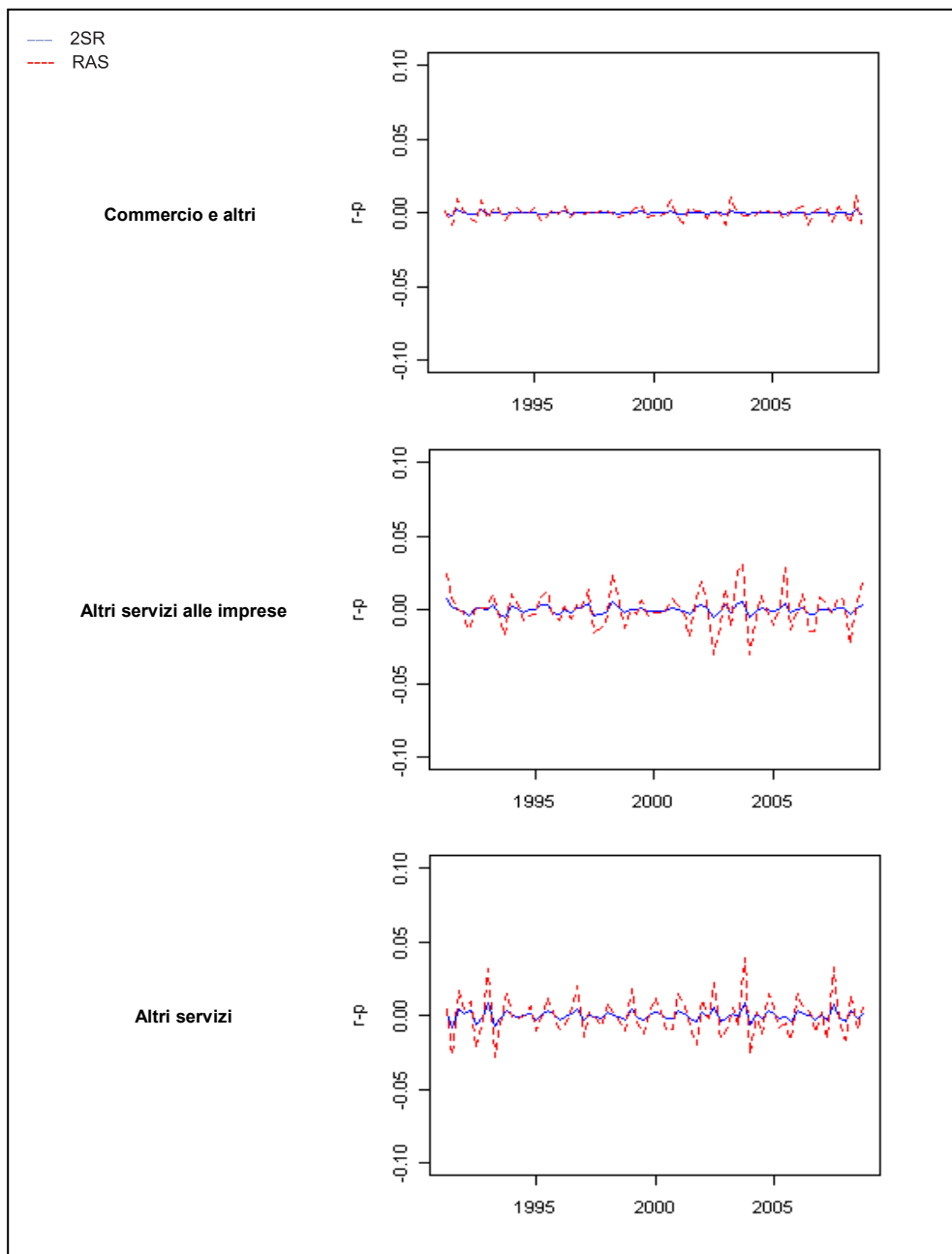
Figura 3 segue - Serie temporali degli aggiustamenti nei tassi di crescita delle ula lorde destagionalizzate: Società non finanziarie

Fonte: Elaborazione su dati Istat

Figura 4 - Serie temporali degli aggiustamenti dei tassi di crescita delle ula lorde destagionalizzate: Famiglie produttrici



Fonte: Elaborazione su dati Istat

Figura 4 segue - **Serie temporali degli aggiustamenti dei tassi di crescita delle ula lorde destagionalizzate: Famiglie produttrici**

Fonte: Elaborazione su dati Istat

6. Conclusioni

In questo lavoro è stato presentato il problema della riconciliazione di serie storiche applicato alle stime trimestrali per settore istituzionale. In tale ambito, infatti, coesistono vincoli contemporanei e temporali da rispettare. Dopo una breve introduzione alle tecniche di bilanciamento più note ed alla metodologia di Denton, sono stati messi a confronto due approcci in un'applicazione basata sui dati destagionalizzati delle Unità di lavoro equivalenti a tempo pieno. I dati analizzati, infatti, costituiscono un sistema di serie storiche soggetto a doppio vincolo contabile. Per poter riconciliare questo sistema di serie con i vincoli esogeni sono state applicate due differenti procedure di riconciliazione a 2 stadi che condividono la stessa tecnica di *benchmarking* (Denton PFD) al primo stadio - ampiamente discussa nella sezione 4.2 - ed entrambe basate sul metodo di aggiustamento che adotta i minimi quadrati al secondo stadio. Tali procedure al tempo stesso preservano la dinamica delle serie preliminari, requisito auspicabile quando nel processo di produzione di dati ad alta frequenza si ricorre all'approccio indiretto: nei QSA, infatti, è necessario conservare l'informazione trasmessa dagli indicatori utilizzati nel processo di trimestralizzazione.

Sulla base di specifiche misure calcolate sui livelli e sui tassi di variazione delle serie riconciliate sono state valutate le performances delle procedure messe a confronto. Tali indicatori sono stati, inoltre, calcolati sulle serie riconciliate - nella seconda parte dell'applicazione - simulando di non poter alterare alcune serie componenti il sistema considerato. L'analisi di questi indicatori è stata eseguita sia a livello di branca (aggregazione a sei branche di attività economica) sia a livello di settore istituzionale (massimo livello di aggregazione). Dall'analisi dei risultati è emerso che la natura della procedura statistica di riconciliazione impone la misura dell'aggiustamento nel senso che è direttamente collegato alla dimensione della variabile da riconciliare: maggiore (minore) è una variabile, maggiore (minore) sarà l'aggiustamento finale. Gli indicatori calcolati sui tassi di variazione evidenziano che l'approccio 2SR, alternativo a quello RAS, ha fornito risultati migliori complessivamente e a livello di settore istituzionale, mentre per quanto concerne l'indicatore sui valori assoluti, i due approcci si sono equivalsi. Il metodo di riconciliazione 2SR, infatti, in un sistema di serie storiche soggetto a vincoli temporali e contemporanei, ha restituito risultati migliori per quanto riguarda il *movement preservation principle*.

La dimensione del problema è un altro aspetto fondamentale da considerare quando un set di serie preliminari deve essere riconciliato tenendo conto di alcuni vincoli contabili: il numero di variabili coinvolte nel processo di riconciliazione, la lunghezza delle serie, il numero di vincoli. Quello trattato costituisce, pertanto, un problema di piccole dimensioni. Tuttavia altri aspetti connessi alla riconciliazione restano da investigare, come ad esempio la valutazione delle performances di tali procedure quando si procede in estrapolazione, ovvero quando non si dispone dell'ultimo dato annuale che costituisce il vincolo temporale e quindi del rispetto del *movement preservation principle* nei trimestri in corso d'anno.

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